INDIAN PAPER INDUSTRY 1948-1965
AN ECONOMETRIC ANALYSIS

A THESIS SUBMITTED
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DOCTOR OF PHILOSOPHY

by

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to the

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CERTIFICATE

This is to certify that the thesis "Indian Paper Industry 1948-1965: An Econometric Analysis", submitted by Shri Raja Ram Barthwal in partial fulfilment of the degree of Doctor of Philosophy of the Indian Institute of Technology, Kanpur, is a record of bonafide research work carried out by him under my supervision and guidance for the last three years. The results embodied in this thesis have not been submitted to any other university or Institute for the award of any degree or diploma.

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HSS 732	Econometrics
HSS 733	Inter-Industry Economics
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"INDIAN PAPER INDUSTRY 1948-1965: AN ECONOMETRIC ANALYSIS" - a thesis submitted in partial fulfilment of the requirements for the Degree of Doctor of Philosophy by R.R. Barthwal to the Department of Humanities and Social Sciences, Indian Institute of Technology, Kanpur, Dec. 1971.

This thesis is concerned with the empirical estimation of the demand, production and cost functions for Indian Paper Industry, by making use of the time series data for the period 1948-64. The role of these functions in industrial planning is well known and it is for this reason that it was felt necessary to have a comprehensive study of the paper industry covering the three aspects with the same set of data. No such comprehensive study focussed on this particular Indian industry has been made before. An effort has also been made to dwell upon certain other relevant aspects of the industry such as trends and structural changes in its inputs and output .

The output of the paper industry comprises of many varieties of paper and paperboard which are generally grouped together into four categories on the basis of use. The categories are: (1) Newsprint; (2) Other Printing and Writing Papers; (3) Wrapping and Miscellaneous Papers and (4) Paperboard. Demand functions have been estimated for each of these four categories as well as their aggregate.

The demand for newsprint, other printing and writing papers and total paper and paperboard has been taken as a function of the national income or non-farm national income, number of students and the price of the relevant categories of paper and paperboard. For the remaining two categories i.e. wrapping and miscellaneous paper and paperboard, the demand has been taken as a function of the non-farm national income and the prices. In the preliminary estimates of the demand functions for different categories of paper and paperboard the price variables were found insignificant with the exception of the newsprint price. This supports the hypothesis that by and large the (aggregate) demand for paper and paperboar is price-inelastic in India. The number of students was also insignificant in the regression fits of the demand functions in which it was included. The main reason for this was the multicollinearity arising out of the common trends in the growth of the national income or non-farm national income and the number of students.

In the final estimates of the demand functions for different categories of paper and paperboard, the national income or non-farm national income has been taken as the sole explanatory variable. For newsprint and other printing and writing papers the log fits of the demand functions were found statistically better than the linear fits. The difference between the log and the linear fits

was, however, marginal. For all practical purposes both the types of fits were found equally acceptable. However, in the case of certain other categories of paper such as wrapping and miscellaneous papers, paperboard and total paper and paperboard, the linear fits were statistically better than the log fits.

Empirical estimates of the production function have been made for measuring the elasticity of substitution between capital and labour, degree of returns to scale, contribution of the different factors of production (capital and labour only) to output and the technological progress in the industry. For this purpose, the VES, the CES and Cobb-Douglas production functions have been fitted to data. The results show that the elasticity of substitution has been constant with an unitary value and are, therefore, more in agreement with the Cobb-Douglas production function. Other findings are constant returns to scale and almost negligible technological progress (in the Hicksian sense) in the industry during the period under study. The output elasticities of capital and labour inputs were found to be of the order of 0.64 and 0.36 respectively.

Estimates of the cost functions have also been made for the industry. They also revealed the prevalence of the constant returns to scale in the industry during

the period under study and thus, were found consistent with the estimates of the production functions. The estimates of the cost functions enabled us to measure the effect of the input prices on cost of production in the industry. The total cost of production was virtually inelastic with respect to prices of capital, labour and fuel inputs. Only for the price of material input, the cost elasticity was found significantly high, varying in magnitude around 0.65.

CHAPTER I

THE ROLE OF PAPER INDUSTRY AND PURPOSE OF THE STUDY

1.1 The Role of Paper Industry:

Paper, in its various forms and qualities has a variety of uses. It is the basic means of communication and dessimination of information. It records almost all the economic, social and political transactions and serves the needs of art, literature and science in preserving the great legacy of human knowledge for future. It carries the symbol of value in the form of money and certificates and provides the means for wrapping and packaging a large number of products. It has got numerous other uses listing of which is a difficult task. Some of them are, however, given in the appendix of this chapter. Being used for cultural as well as for industrial purposes paper has come to be regarded as one of the prime necessities of modern life. The consumption of paper in percapita terms, is now considered as a measure of the development and progress of civilization. The percapita consumption of paper is very high in the developed countries like U.S.A., Sweden, Canada, U.K., and Japan etc. as compared to the underdeveloped countries like India, Indonesia, Burma, Jordon and Kenya etc. In other words, as we will see later on, percapita consumption of paper displays a very high degree of correlation with the

percapita income which is usually taken as a measure of the economic development of a nation.

In view of the indispensable role of paper in modern civilization, the paper industry has acquired an important position in the manufacturing industries of the world. From the point of view of value added, the industry ranks within first 10 major manufacturing industries in most of the developed countries such as U.S.A., U.K., France, Germany, Canada, Sweden, Finland, Norway, Newzealand, Japan and Austria In Finland, Norway, Sweden and Canada, paper industry is almost a leading industry in the manufacturing sector. In the developing countries of Asia and the Far East, Latin America and Eastern Europe, paper industry is relatively behind in ranking but it is coming up rapidly (U.N.O. 1963). Although there are differences in the ranking or degree of development of the paper industry in different countries of the world, it is truely world wide in scope.

The importance of paper industry can best be understood in the light of its spectacular growth during the past two centuries. The development of modern paper industry started from the beginning of 19th century When the paper machine was invented and manufacturing processes for the conversion of wood into paper pulp were discovered. Since then the industry has made a rapid progress in different part

of the world. For example, today U.S.A. is the top paper producing country in the world. In this country during the period 1899 to 1958 alone, growth in the paper industry was about 67 times of its 1899 level as against 33 times in the manufacturing sector as a whole (Britt, 1964). This spectacular growth of the paper industry in the U.S.A. and similarly in other parts of the world has been the result of increasing demand for paper and paper board arising from the economic development. Recent trends in the growth of world paper industry, particularly after the second world war, reveal some interesting features which further highlight the importance of paper industry in a growing world.

In table 1.1 we have presented the average annual rates of change in production for paper industry and for the entire manufacturing sector in different zones of the world covering the period 1938-61. From the table we find that during this period and in its different segments (1938-48, 1948-53, 1953-58 and 1958-61) paper industry grew faster than the entire manufacturing sector in Europe, Africa, Latin America, Asia and the Far East (excluding Japan) and Oceania. On the other hand, in Northern North America consisting the U.S.A. and Canada, the industry grew at slower rates. On the whole in industrially developed countries the growth of the industry was slower as compared with the growth of the manufacturing sector as a whole, but the position in the

developing or less industrialized countries was just reverse. In these countries growth of the paper industry was faster than that of the manufacturing sector. In view of the important role of paper in the society, growth of the paper industry in the early phase of industrialization as experienced by the present developed countries in 19th century and recently by the developing countries, seems to be quite natural.

In the post-war period, especially, during the period 1951-61, demand for paper and paper board has increased rapidly throughout in the world. The rates of increase in the demand, however, differed from country to country. As shown in table 1.2 in Asia and the Far East the annual average rate of growth in total consumption of paper and paper board was maximum (14.5%). It was followed by Africa (8.0%), U.S.S.R. (7.9%), Europe (7.6%), Latin America (6.2%) and at the bottom was North America (3.2%). From these figures we can infer that in comparison with the developed countries of the world, demand for paper and paperboard has increased with faster rates in the developing countires. This is expected in view of the rapid expansion of paper using sectors such as education, mass-communication and business etc. in these countries. In order to have pace with the demand, growth of the paper industry in these countries was, therefore faster than that of the developed countries. If we compare the absolute growth in production (or consumption) of paper

and paperboard and not its rate, we will find the developed countries far ahead of the developing countries. Table 1.4 shows the facts. In 1953, the production of paper and paperboard in the United States was 11553 thousand metric tons as compared with 122 thousand metric tons in India. In 1966, United States produced 40696 thousand metric tons as against 614 thousand metric tons by India. Similarly, growth in the production of paper and paperboard in other developed countries since 1953 was far greater than that of India or any other developing country. In 1966 (or prior to that) more that 80% of world production of paper and paperboard was shared by 10 developed countries only, among them U.S.A. was at the top having 39.47% share followed by Canada 1_.47% and Japan 7.95%. Remaining seven countries had 1.03 to 4.33% shares (Ref: Table 1.4). During the period 1950-62 the percapita consumption of paper has increased from 382 to 453 lbs. in U.S.A.; from 102 to 233 lbs. in U.K.; from 22 to 126 lbs. in Japan and from 60 to 186 lbs. in West Germany. Similar trends were seen in the growth of percapita consumption of paper in other developed countries (Britt, 1964, Chapter 1). On the other hand, increase in the percapita consumption of paper and paerboard in developing countries was extremely low. In India, for example, it has increased by 1.4 lbs. i.e. from 1.3 to 2.7 lbs during the period 1950-51 to 1961-62. The extraordinary growth of the percapita consumptio

in developed countries itself indicates the higher growth of their paper industry.

Seeing the trends in the growth of world paper industry, we may conclude that it is a 'growth industry' that is, the industry has a tendency to grow with the economic progress of a nation. From the crosssectional data given in Table 1.5 we can statistically verify this conclusion. In the table we see that countries with high ranks in percapita income also have high ranks in percapita consumption of paper. In other words, there is a positive rank correlation of a very high degree (0.97) between these two variables. Similarly, we find significantly high degree of rank correlation between percapita income and percentage share of paper industry in value added by the manufacturing sector (R=0.56) or total number of persons employed in it (R=0.59). On the basis of these correlation coefficients, we can say that as economy of a nation develops (increase in percapita income), the demand for paper and paperboard increases because of the expansion of paper using sectors such as education, business and industires, resulting in the growth of the industry.

1.2 Evolution of Modern Paper Industry in India:

The beginning of large scale paper industry in India dates back to 1832 when the first paper mill was established by Dr. Carey at Serampore in West Bengal. This venture,

however, failed after a few years. Meanwhile in 1867 another paper mill named as the Royal Paper Mills was established near Balley in Bengal and the machine of Serampore mill was also transferred to this mill in 1870. In 1881 the Upper India Couper Mills started functioning at Lucknow in U.P. and in 1884 the Titagarh Paper Mills at Calcutta. Soon after, the Deccan Paper Mills at Poona (1887) and the Bengal Paper Mills at Raniganj (1889) came into existence. All these mills mentioned above, used wastepapers, rags, and grasses (Mooj and Sabai) as basic raw materials for manufacturing of the paper. The shortage of raw materials and imported pulb put all of them under handicaps restricting the growth of the industry inspite of the increase in demand for paper.

The research work carried out by the Forest Research Institute, Dehra Dun during the period 1906-1912 led to the discovery of bamboo as a potential raw material for large scale paper manufacturing (Guha, 1963). As a pilot plant, Titagarh Paper Mills was first to utilise the bamboo technology on a limited scale in 1912. Gradually, all the existing mills went in for the bamboo use. The discovery of bamboo as a raw material for paper manufacturing and high demand for paper during the first world war gave a new life to the Indian paper industry. In the early inter war period, however, the industry had to face a

tough competition from abroad, so the Government of India granted protection to it under the Bamboo Paper Industry Act 1925. With this, the industry entered the second phase of development. The production rose steadily from 33000 tonnes in 1924 to 59200 tonnes in 1938-39. The second World War became the turning point for the Indian paper industry and in a way supported its expansion. By 1947 the industry was strong enough to maintain its growth and face the world competition. Hence the protection granted to it in 1925 was withdrawn. Inspite of this, the growth of the industry was very much impressive in the post-Independence period. This was the third and most important stage in the growth of the industry in India. By 1950 the production of the industry increased to 108912 tonnes per year which was almost double of the 1938-39 level. From 1950 to 1968 the industry has recorded about 600% growth as against 300% by the industrial sector as a whole in the country. This extraordinary growth of the industry was due to increase in demand for paper and paperboard and the planned efforts of the nation for the development of industries as a whole. At present the industry has acquired the status of a major industry in the country with bright scope for further growth.

1.3 Future Prospects of the Growth of Paper Industry in India and the Need for Estimating Demand, Production and Cost Functions:

As we have mentioned above, during the last twenty years

the Indian paper industry has made very rapid progress in the wake of rising demand for its products. There is no doubt that the industry will continue to grow in future in response to the likely growth of paper using sectors such as education, mass-communication, business and industries in the country. In this context the important thing is to know the rate at which the industry should grow, so that its future production can be planned in such a way to avoid the fitfalls of scarcity as well as overproduction. This can be known by estimating the demand function for paper and paperboard in the country. Planning also requires information regarding the input-output relationship and behaviour of the costs with respect to output of the industry. Vital decisions regarding the establishment of new units and expansion of old units should be taken on the basis of such information. Technological progress has been an important feature of modern industrialization and it is necessary to asses its role in increasing the production of paper and paperboard in the country. For all this additional information namely, the input-output and cost-output relationships, we need to derive the production and cost functions for the Indian paper industry. The cost function in a sense, is a reduced form of the production function. It reveals the same thing in a different way as the production function does. At the same time, it tells us about the effect of input prices on cost of production. This information which is very much

significant in the context of national planning can be provided only by the cost function. Hence there is a need for fitting in this function for the Indian paper industry. This, along with the empirical estimates of the demand and production functions, for the industry, will greatly help us in envisaging the future growth of the industry in the country.

There is no single study covering all these aspects of the paper industry in India. Specific aspects of the industry, however, have been studied in a scattered manner by certain institutions such as F.A.O. & N.C.A.E.R. Even these suffer from some limitations. The estimates of the demand functions have been made by the F.A.O. (1962), N.C.A.E.R. (1965) and E.S.R.F (1969). The first two studies covered the period 1948 to 1958. They are now out of date. The third one has been conducted quite recently. It covered the period 1951-1965. In this study the main focus was on basic raw material requirements of the industry considering the future prospects of the demand for paper and paperboard in the country. To forecast the demand for different categories of paper and paperboard in the country, some demand functions were fitted, in which the percapita consumption of paper and paperboard was taken as a logarithmic function of the percapita income alone. Although the use of percapita income as the sole explanatory variable for percapita demand of paper and paperboard was quite common in most of the studies for developed countries (Ref: Chapter 4,

Section 4.4.2), for us it looks somewhat very much crude. In India because of the high mass illeteracy (70% according 1971 Census) the whole of the population is not a relevant demand factor for paper and paperboard. A better approach to fit the demand functions for paper and paperboard in the country would be to use the variables in aggregate form rather than their percapitas as done in the NCAER study. Apart from the national income some other relevant demand factors such as the number of literates or students, prices and trend should also be incorporated in the empirical estimates of the demand functions for paper and paperboard in the country. In all the three studies cited above the consumption series for different categories of paper and paperboard have been derived from the 'Monthly Statistics of Production' data (Ref: Chapter 2 for details) which excludes the output of the small scale sector of the industry. They are, thus, obviously underestimated consumption series and, therefore, the demand functions derived from them are not very much reliable.

Estimates of the production function for the industry were made by Murti and Sastry (1957), Yeon Her Yeh (1966), and others. (Dadi (1970); Dutt (1955); Diwan (1967); Ulganathan (1970)). These studies are mainly based on crosssectional data for limited purpose of the enquiry. They give conflicting results. For example, Murti and Sastry show constant returns to scale prevailing in the industry

but Prof. Yeh shows increasing returns to scale. The actual state of affairs has not yet been established fully for the industry, particularly with the time series data. In the long run, manufacturing processes undergo changes because of the technological progress. Hence the results of a long run production function for the industry may be quite different from its short run counterpart.

In view of the limitations or defects of the existing studies on demand and production functions for the Indian paper industry, there is need for a fresh study of these functions with the time series data. This is the objective of this study. Estimation of the cost function for the industry which is almost untouched so far will also be a part of this study. Thus, what we aim at is a comprehensive study focussed on the industry as such estimation of the demand, production and cost functions together from the same set of data.

1.4 <u>Plan for the Study</u>:

As mentioned above, the purpose of this study is to estimate the demand, production and cost functions for the Indian paper industry. For this, the plan of the study is as follows:

In Chapter 2 we will be dealing with the data for the study. Chapter 3 will have the background information regarding the growth and structural changes in the industry

for the period 1948-64. In Chapters 4,5 and 6 we will be dealing with the estimation of the demand, production and cost functions respectively. Finally in Chapter 7, the summary and conclusions will be presented.

Table 1.1

Average Annual Growth (%) of Industrial Production
(Value Added at 1958 Prices)
A Comparison of All Manufacturing & Paper
Industry in Different Zones of the World

Period	World[3]		Industrialized Countries		Less Industrialized countries		Northern North-America		Latin America	
	All[1]	Paper[2]	All	Paper	All	Paper	All	Paper	All	Pape
1938-61	5.0	4.9	4.9	4.8	5.6	7.6	5.5	5.2	5.8	6.8
1938-41	4.2	3.6	4.3	3.6	3.7	4.2	8.1	6.2	5.8	6.4
1948-53	6.9	6.4	7.1	6.3	4.8	9.0	6.2	4.7	4.0	4.4
1953-58	3.4	5.0	2.9	4.7	9.1	12.2	0.3	3.6	7.8	10.0
1958-61	7.00	6.7	6.9	6.6	7.4	9.1	5.4	5.2	5.8	6.7

Period	Africa		Asia & the Far East		Asia & the Far East (Exclud. Japan)		Oceania		Europe	
	All	Paper	All	Paper	All	Paper	All	Paper	All	Paper
1938-61	5.6	NA	6.4	8.2	5.0	8.6	4.3	10.8	4.0	4.3
1938-41	NA	-3.3	-5.2	1.2	3.1	3.6	11.6	-	-	-
1948-53	7.1	32.6	12.5	26.3	4.7	11.9	5.8	13.9	7.8	8.3
1953-58	5.5	9.1	11.7	10.4	10.5	13.6	5.1	10.5	6.4	6.9
1958-61	3.8	9.1	19.4	19.2	9.2	13.5	2.6	3.8	7.3	7.5

Notes: 1. 'All' means All Manufacturing excluding Mining & Electricity Generation.
2. 'Paper' means Pulp & Paper Industry.
3. 'World' excludes USSR and Eastern European Countries because the data for these countries was not comparable with that of others. However, the average annual growth of Pulp and Paper Industry in these countries during the periods 1950-60, 1953-58 and 1958-61 was 8.8%, 7.7%, and 7.4% respectively.

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4 & 5. Industrialized countries are those for which value added per-capita in manufacturing industry was $ (U.S.) 125 during 1958. According to this definition the countries falling in the categories of 'industrialized' and'less-industrialized' are:

<u>Industrialized Countries</u>: North America European Economic Community, European Free Trade Area; Oceania and Japan.

<u>Less-Industrialized Countries</u>: Africa (excluding South Africa); Latin America; Asia (excluding Japan); and Southern Europe (excluding Italy);

For list of countries grouped together in different zones, the source mentioned below can be referred.

Source: U.N: Growth of World Industry 1938-1961; International Analysis & Tables; New York, 1963; pp. 156-158.

Table 1.2

Growth in Recorded Consumption of Paper & Paperboard

	Quantity: Million Tonnes		Average Rate of Growth
	1950-52 %	1960-62 %	1951-61 %
1	2	3	4
Total Consumption			
Europe	10.99 (24.90)	22.87 (29.5%)	7.6
U.S.S.R.	1.63 (3.7)	3.47 (4.6)	7.9
North America	27.28 (61.5)	37.37 (48.3)	3.2
Latin America	1.44 (3.3)	2.63 (3.4)	6.2
Africa	0.38 (0.90)	0.82 (1.06)	8.0
Asia & Pacific	2.62 (5.9)	10.17 (13.10)	14.5
World Total:	44.33 (100.0)	77.33 (100.0)	5.7
(a) Newsprint:			
Europe	2.03 (22.3)	4.16 (28.6)	7.4
U.S.S.R.	0.22 (2.4)	0.43 (2.9)	7.1
North America	5.73 (63.0)	7.12 (49.1)	2.2
Latin America	0.42 (4.6)	0.73 (5.0)	5.7
Africa	0.08 (0.9)	0.17 (1.4)	7.4
Asia & Pacific	0.61 (6.8)	1.89 (13.0)	11.9
World Total:	9.09 (100.0)	14.50 (100.0)	4.8

(Table 1.2 conu.)

1	2	3	4
(b) Other Printing & Writing Papers			
Europe	2.37 (29.6)	4.79 (34.0)	7.3
U.S.S.R.	0.34 (4.3)	0.73 (5.2)	7.8
North America	4.40 (55.2)	6.36 (45.2)	3.7
Latin America	0.25 (3.1)	0.41 (2.9)	5.1
Africa	0.06 (0.1)	0.18 (1.3)	12.2
Asia & Pacific	0.55 (6.7)	1.61 (10.4)	11.4
World Total:	7.97 (100.0)	14.08 (100.0)	5.9
(c) Industrial Papers Including Paperboard			
Europe	6.60 (24.2)	13.92 (28.6)	7.8
U.S.S.R	1.07 (3.9)	2.32 (4.8)	8.1
North America	17.14 (62.9)	23.89 (48.9)	3.4
Latin America	0.77 (2.8)	1.48 (3.0)	6.8
Africa	0.24 (0.9)	0.47 (0.9)	6.9
Asia & Pacific	1.46 (5.3)	6.67 (13.8)	16.4
World Total:	27.27 (100.0)	48.75 (100.0)	6.0

Note: Figs. in brackets show percentage share in world consumption

Source: Unasylva; Wood: World Trends and Prospects, Vol. 20 (1,2) Numbers 80-81, 1966, page 27-28: Quoted in E.S.R.F: Pulp & Paper; Prospects for 1975 (Statement V, page 136) New Delhi, 1969.

Table 1.3

Index Numbers of Industrial Production (Value Added at 1958 Prices) in 10 Main Paper Producing Countries of World

Index 1958 = 100

Year	FINLAND All[1]	Paper[2]	NORWAY All	Paper	SWEDEN All	Paper	CANADA All	Paper	NEWZLALAND All	Paper
1	2	3	4	5	6	7	8	9	10	11
1948	61	49	58	62	74	69	69	70	60	23
1949	63	46	63	64	77	65	71	74	64	22
1950	67	54	70	73	80	72	75	81	67	27
1951	78	64	75	78	83	78	82	87	71	29
1952	74	55	74	73	81	68	84	84	71	29
1953	78	60	78	80	83	74	90	87	75	36
1954	91	75	85	89	87	85	87	92	83	45
1955	100	86	92	95	92	91	96	97	88	65
1956	103	91	96	95	95	96	103	102	88	76
1957	104	100	100	101	98	101	102	100	95	93
1958	100	100	100	100	100	100	100	100	100	100
1959	110	107	106	108	102	109	106	107	104	107
1960	125	125	117	121	108	126	106	109	114	117
1961	137	145	127	125	112	131	109	113	-	-
Average Annual Growth Rates 1950-60	6.4	8.8	5.3	5.2	3.0	5.8	3.5	3.0	5.5	15.8

Foot Note: 1 'All' means All Manufacturing Industries excluding Minin
2. 'Paper' means Pulp & Paper Industry.

Contd

(Table 1.3 contd)

Year	PORTUGAL All	PORTUGAL Paper	USA All	USA Paper	AUSTRIA All	AUSTRIA Paper	JAPAN All	JAPAN Paper	INDIA All	INDIA Pape
1	12	13	14	15	16	17	18	19	20	21
1948	-	-	74	66	35	41	18	16	66	40
1949	-	-	70	63	48	51	24	23	63	42
1950	-	-	82	76	57	58	30	31	62	44
1951	-	-	88	80	65	64	43	43	70	54
1952	-	-	92	77	64	60	46	49	73	56
1953	68	35	99	83	64	69	57	62	74	57
1954	76	63	92	84	74	86	63	68	79	63
1955	81	79	104	95	88	94	68	78	86	75
1956	88	91	108	100	92	95	84	90	94	78
1957	94	99	108	99	98	101	100	102	97	86
1958	100	100	100	100	100	100	100	100	100	100
1959	105	106	114	110	106	105	126	126	108	114
1960	116	130	117	111	118	116	161	147	120	136
1961	128	138	118	117	124	118	193	173	128	143
Average Annual Growth Rates 1950-60	-	-	3.6	3.9	-	-	18.3	16.8	6.8	11

Source: U.N.O. Growth of World Industry 1938-1961 National Tables; New York 1963.

Table 1.4

Production of Paper & Paperboard 1953,1960 & 1966

Country	1953 Production 000 Tonne	1953 % of World Production	1960 Production 000 Tonne	1960 % of World Production	1966 Production 000 Tonne	1966 % of World Production
1. USA	11553	35.95	15247	31.07	40696	39.47
2. Canada	5832	18.15	7001	14.27	10792	10.47
3. U.K.	1678	5.22	2746	5.60	4467	4.33
4. U.S.S.R.	1598	4.97	2334	4.76	3568	3.46
5. Germany FDR	1476	4.59	2551	5.20	4348	4.22
6. Sweden	1314	4.09	2084	4.25	3483	3.38
7. Japan	1308	4.07	2968	6.05	8195	7.95
8. France	1147	3.57	2230	4.54	3451	3.35
9. Finland	739	2.30	1462	2.98	3461	3.36
10. Norwa	449	1.40	744	1.52	1065	1.03
11. Australia	131	0.41	288	0.59	786	0.76
12. India	122	0.38	312	0.64	614	0.60
13. Rest of World	4788	14.92	9126	18.53	18169	17.62
WORLD TOTAL	32135	100.00	49073	100.00	103095	100.00

Source: U.N. Statistical Year Book 1968
Tables 112,113, pp. 276-277.

Table 1.5

Ranking of Some Non-Communist Countries According to Their Percapita Income, Percapita Consumption of Paper & Paperboard and Percentage Share of Paper Industry in Value Added and Number of Workers Employed in the Manufacturing Sector.

Country	Share of Paper Industry in Value Added		Share of Paper Industry in No.of Workers		Percapita Income (1958)		Percapita Income 1963		Percapita Consumption of Paper & Paper-board 1963	
	% in 1958	Rank of the country	%in 1958	Rank of the country	US$	Rank of the country	US$	Rank of the country	Lbs.	Rank of the country.
1	2	3	4	5	6	7	8	9	10	11
1.Argentina	1.8	33	1.6	34	489	19	481	22	70.0	20
2.Australia	3.0	17	2.1	22	1126	6	1480	6	181.0	11
3.Austria	4.1	8	4.0	5	588	17	831	16	101.0	16
4.Belgium	3.4	14	3.4	9	936	9	1191	12	152.0	13
5.Brazil	2.3	25	1.9	27	189	32	243	32	22.0	33
6.Burma	0.1	46	0.2	46	53	46	59	46	3.0	44
7.Canada	9.1	4	7.0	4	1503	2	1602	4	295.0	2
8.Chile	1.9	31	1.6	33	326	23	260*	31	35.0	25
9.China (Tiwan)	2.0	28	2.1	23	100	40	151	38	24.0	32
10.Columbia	1.4	35	1.5	35	189	33	263	30	28.0	30
11.Denmark	3.6	11	3.3	10	888	10	1335	7	220.0	7
12.Finland	16.2	1	9.9	1	727	13	1129	13	172.0	12
13.France	2.5	21	2.5	18	1003	8	1321	8	141.0	14
14.W.Germany	3.1	16	2.7	17	838	12	1254	10	186.0	10
15.Greece	2.0	29	1.9	28	326	24	459	24	29.0	29

contd...

'able 1.5 contd.)

1	2	3	4	5	6	7	8	9	10	11
).India	3.5	12	2.0	24	64	44	80	45	2.00	45
'.Indonesia	1.4	36	110	38	81	41	82	44	1.10	46
:.Ireland	3.5	13	3.2	11	464	21	650	19	95.0	17
).Israel	0.9	43	1.1	37	610	16	836	15	67.0	21
).Italy	1.7	34	1.8	29	478	20	763	18	87.0	18
.Japan	3.9	9	3.5	7	284	26	559	21	126.0	15
:.Jordon	0.4	45	0.3	45	141	37	184	37	8.0	40
.Kenya	1.2	40	0.6	42	69	43	87*	42	7.2	41
.Korea(s)	1.9	32	2.0	25	126	38	128	40	9.2	37
.Lebanon	0.5	42	0.6	43	208	30	294	29	24.0	31
.Mexico	2.5	22	2.4	19	272	27	349	27	33.8	27
.Netherland	3.3	15	2.3	21	695	14	996	14	232.0	6
.New Zealand	6.4	5	3.1	12	1172	5	1502	5	199.0	8
.Norway	9.8	2	8.4	2	871	11	1205	11	196.0	9
.Pakistan	2.4	24	1.7	32	62	45	82	43	3.4	43
.Peru	2.5	23	1.8	30	163	35	202	35	17.3	34
.Philippines	2.1	27	1.3	36	193	31	218	34	17.0	35
.Portugal	4.8	6	3.4	8	216	29	298	28	34.0	26
.Puerto Rica	1.3	37	0.8	41	542	18	827	17	85.0	19
.Singapore	1.0	41	1.0	39	420	22	478	23	53.0	23
.S.Africa	3.8	10	2.8	13	314	25	397	26	51.0	24
.Spain	2.8	20	2.8	14	229	28	441*	25	32.0	28
.Sweden	9.4	3	7.4	3	1383	3	1939	2	282.0	3

(Table 1.5 contd.)

1	2	3	4	5	6	7	8	9	10	11
39.Switzer-land	2.8	18	2.8	15	1195	4	1677	3	232.0	5
40.Thailand	1.0	42	1.0	40	80	42	98	41	6.1	42
41.Tunisia	2.3	26	2.3	20	152	36	193	35	8.1	39
42.Turkey	1.3	38	1.7	31	179	34	223	33	8.8	38
43.U.A.R.	2.0	30	2.0	26	111	39	140	39	15.0	36
44.U.K.	2.8	19	2.7	16	1012	7	1300	9	233.0	4
45.U.S.A	4.1	7	3.6	6	2115	1	2562	1	453.0	1
46.Venezuela	1.2	39	0.6	44	630	15	605*	20	64.0	22

Foot-notes:

*Percapita Income figures are not comparable with previous years.

Source: United Nation's Statistical yearbooks.

Appendix 1.1

List of Important Varieties of Paper and Paperboard and Their Uses

Sl.No.	Variety	Uses
1.	Abrasive Paper	Used in abrasing metal and wood surfaces.
2.	Absorbant Papers	Used in blotting, duplicating and wadding.
3.	Air Mail Papers	In making envelopes for Air Mail letters.
4.	Ammunition Paper	Wrapping the cartridges etc.
5.	Angle Papers	Manufacture of En-velopes.
6.	Anti-acid Manillas	Insulating Cables.
7.	Art Paper	Drawings & Painting.
8.	Backing Papers	Used in Stereo-typing.
91	Bag Paper	Manufacturing of bags.
10.	Banks Paper	Special writing paper with high strength but lighter weight.
11.	Bank Note papers	Used in printing of currency notes.
12.	Bible Paper	Thin printing paper of good quality.
13.	Bill Papers	Documentation as promissory notes, bills of exchange etc.
14.	Blotting papers	Used for absorbing ink or other liquids.
15.	Bond papers	Used in writing and printing works.
16.	Bowl paper	Used for the rolls in calendering machines.

Sl.No.	Variety	Uses
17.	Box Boards	In making boxes etc.
18.	Bright Enamel paper	Used for levels.
19.	Bristol Boards	For black and white drawings.
20.	Brown Paper	Wrapping and packaging.
21.	Butter Papers	Wrapping of Butter and similar products.
22.	Cable papers	Insulating the cables.
23.	Calender Rolls	Used for the rolls in calendering machines.
24.	Caps	Thin wrapping.
25.	Carbolic Paper	Special type of wrapping and packaging works.
26.	Carbon paper	Used in typewriting for taking extra copies.
27.	Cards	Used in making play cards etc.
28.	Carpet Felt paper	Used for placing under carpets to prevent making by floor boards or to give better feel to the floor covering.
29.	Carriage Panels (Mill Board Variety)	In roofing railway and other carriages.
30.	Cartridges	Strong papers used in making cheap drawings etc.
31.	Cashings paper	Thin brown paper used for lining cases, crates etc.
32.	Cellophane	Transparent wrapping.
33.	Cellulose wadding	Used mainly in wadding.
34.	Chart papers	Used for printing charts and maps.

Sl.No.	Variety	Uses
35.	Cheque papers	Used in making cheque books.
36.	Chromo papers	Colour lithography.
37.	Cigarette papers	Used in manufacturing cigarettes.
38.	Coth-lined paper	Used for wrapping purposes where much handling is required.
39.	Cobbs papers	Special end papers used mainly in book binding.
40.	Coils	General uses in telegraphs, calculat and time recording machines, etc.
41.	Collar Papers	For making paper collars & similar article.
42.	Copying paper	Taking press copies of correspondenc
43.	Cork paper	Packing bottles etc.
44.	Corrugated papers	Protective packaging for a variety of products.
45.	Crayon paper	Drawing papers specially prepared fo crayon work.
46.	Cutlery papers	Wrapping cultery and similar article
47.	Cover paper	Packaging.
48.	Crepe papers	For fine work such as artificial flowers.
49.	Detail papers	Tracing of drawings etc.
50.	Drapers caps	Wrapping small articles.
51.	Drawing papers	In making drawings and paintings.
52.	Drying Royal	Used in copying of books.
53.	Duplex papers	Used as art papers.
54.	Duplicating papers	Used in duplicating.

Sl. No.	Variety	Uses
55.	Embossed papers	Used as cover paper
56.	Enamelled papers	Used as cover paper
57.	En-velope paper	Manufacture of enev-lopes.
58.	Feather weight paper	Printing books which are supposed to be bulky.
59.	Filter papers	Used in chemical processes
60.	Foil paper	Wrapping and decoration
61.	Fruit paper	Wrapping of fruits.
62.	Glassine (glacine)	Packaging.
63.	Glazed boards	Used for insulation purposes.
64.	Glazed imitation parchment	Fine packing paper
65.	Grass bleached tissues	Wrapping silver goods and protecti metal decorations and buttons on uniforms.
66.	Grease proof papers	Packing butter, lard and other provisions.
67.	Grocery papers	Packaging.
68.	Hosiery papers	Wrapping.
69.	Illustrated letter	Writing.
70.	Imitation Art paper	Drawing.
71.	Impression paper	Duplicating.
72.	Index Boards	Card Indexing.
73.	India Proof Paper	Duplicating
74.	Insulating paper	Insulation.
75.	Japanese Coping	Coping of books etc.

Sl.No.	Variety	Uses
76.	Japanese Vellums	Thick paper especially made for printing of certificates etc.
77.	Kraft paper	Strong wrapping.
78.	Leather Boards	Box Making
79.	Ledger paper	Making ledgers.
80.	Lined Brief	Writing.
81.	Linen-faced papers	For writing as well as packaging purposes.
82.	Lithographic paper	Lithography.
83.	Loan papers	Writing work especially in banks.
84.	London Boards	Drawing paper.
85.	Long Elephants	Wall - printing.
86.	Magazine paper	Printing magazine etc.
87.	Manifold banks	Typewriting.
88.	Manifold paper	Taking extra copies in typewriting
89.	Manilla papers	Parcel tags, cartoon cover, index card etc.
90.	Map paper	Printing of maps and chart.
91.	Marbled papers	Book Binding.
92.	Matrix board	Used in making of stereotype moulds.
93.	Metallic paper	Special writing work.
94.	Middles	Bus and train tickets.
95.	Mill Boards	Binding, Box Making etc.
96.	Mottled papers	Used for packaging purposes.
97.	Mould made papers	Writing works.
98.	Music papers	Printing sheet music.

Sl.No.	Variety	Uses
99.	Nature Brown	Writing works.
100.	News print	Newspaper printing.
101.	Oiled paper	Drawings and painting.
102.	Onion skin	Writing and packaging works.
103.	Pamphlet paper	Printing of pamphlets.
104.	Parcel Tape paper	Used with special damping machine.
105.	Parchment papers	Impervious packaging.
106.	Paste Boards	Used in making of boxes etc.
107.	Pastings	Used in making of boxes and as cover paper.
108.	Plate papers	Fine lithography.
109.	Porcelain paper	Used in christmas cards or similar work.
110.	Portmantean Boards	Boxes etc.
111.	Poster paper	For making posters.
112.	Pottery paper (tissues)	Special printing work.
113.	Pressings	Packaging etc.
114.	Press Boards	Insulating purposes.
115.	Printings	Printing of books.
116.	Profile papers	Used in surveying work.
117.	Programme papers	Printing of books.
118.	Pulb Board	Used for all purpose where cards are employed.
119.	Railway Buffs	Used in making forms and en-velope
120.	Rice Paper	Small painting and artificial flowers.

Sl.No.	Variety	Uses
121.	Rocket paper	Making cases for rockets.
122.	Royal Hand	Wrapping etc.
123.	Safety cheque paper	In making cheque books for banks.
124.	Sampling papers	Display of textile etc.
125.	Sealings	Used as parcel paper.
126.	Sectional paper	Used in making graphs, chart etc.
127.	Sensitised paper	Used in photography.
128.	Shops	White paper used in packaging.
129.	Silurian	Printing & Writing works.
130.	Skips	Wrapping.
131.	Small Hands	Thin wrapping.
132.	Squared papers	Used for ploting graphs etc.
133.	Stencil paper (oiled)	Stencils for duplicate prints.
134.	Stencil paper	Stencils for duplicate prints.
135.	Stereotyping papers	Stereotyping works.
136.	Straw Board	Used for binding and mounting purposes.
137.	Sulphate wrapping	Wrapping of goods.
138.	Super calendered papers	Printing & writing.
139.	Surfaced coloured paper	Printing and writing.
140.	Tea cartridges	Used for packaging, especially in tea industry.
141.	Ticket Boards	Making tickets etc.
142.	Tips	Binding.

Sl.No.	Variety	Uses
143.	Tissues	Wrapping
144.	Tobacco Papers	Packaging tobacco.
145.	Toilet paper	Used in toilet.
146.	Tracing paper	Tracing of drawings.
147.	Transfer paper	Used in Lithography.
148.	Transparent cellulose	Wrapping purposes
149.	Triplex Boards	Used in industries for a variety of purposes.
150.	Tube Papers	Used in making paper tubes.
151.	Twin wire paper	Used in manufacture of Pulp Boards.
152.	Type writing papers	Typewriting.
153.	Vegetable Parchment	Packaging vegetable products.
154.	Vellum paper	Writing purposes.
155.	Vulcanised Fibre	Making of boards especially used in chemical industry.
156.	Whatman Boards	Thick paper boards used for variety of purposes.
157.	Wheat stone paper	Recording telegraphic messages.
158.	Waterproof paper	Printing and writing works as well as other uses.
159.	Waxed paper	Used in packaging.
160.	Willesden paper	Printing and writing works.
161.	Wiping-off paper	Used for relief stamping machines.
162.	Wood Pulp board	General uses

Sl.No.	Variety	Uses
163.	Wrapping papers	Wrapping
164.	Writing papers	Writing and printing.

Source: E.A. DAWE: Paper & Its uses: Vol. II,
London. Technical Press Ltd. 1939, pp.58-86.

CHAPTER 2

ESTIMATION OF THE VARIABLES

2.1 Major Data Sources:

The objective of this study, as we have mentioned in the preceeding chapter, is to estimate the long-run demand, production and cost functions for the Indian paper industry. For this we need the timeseries of data on different categories of output and inputs of the industry and their prices, national income, number of students and so on. Most of these data series are available from the following two important sources:

1. Reports on Census of Indian Manufacturers - covering the period 1946 to 1958; and

2. Reports on Annual Survey of Industries which cover the period 1959 onwards.

The reports on Census of Indian Manufacturers, are official publications of the Government of India on the census results of the manufacturing industries carried out from 1946 onwards under the provisions of the 'Industrial Statistics Act 1942' and 'Census of Manufacturing Rules 1945'. From 1959 onwards, the census of the manufacturing industries is being carried on under the provisions of the 'Collection of Statistics Act 1953' and 'Collection of Statistics (Central) Rules 1959', the results of which are published annually by the Government of India under the

title 'Annual Survey of Industries'. Under the CMI scheme the census was statutory except for the years 1957 and 1958, and it covered only 29 industries out of 63. The factories and workshops controlled by the Ministry of Defence and those attached with the colleges and institutions for training or educational purpose were excluded from this. In the ASI scheme (1959 onwards) the census was extended on voluntary basis to all manufacturing industries. However, defence factories, oil storage depots and workshops attached with the colleges and institutions continued to be excluded. In addition to this, the factories falling within the coverage of the Mining Act were excluded upto 1962 but included since then.

In the CMI reports the data for the paper industry has been compiled in one major group known as 'Paper and Paperboard (including strawboard)' but in the ASI reports it is given separately for the seven subgroups of the industry following the International Standard Industrial Classification. These subgroups are:

Major Group 27: Manufacture of Paper and Paper products

Group 271: Manufacture of Pulp, Paper and Paperboard

271-1: Pulp: Wood Pulp, mechanical pulp; chemical pulp including dissolving pulp.

271-2: Paper: Printing, writing and wrapping.

271-3: Newsprint.

271-4: Paperboard and strawboard.

271-5: Paper for packaging: Corrugated paper, kraft paper, paperbags and paper cartoons.

271-6: Hardboard including fibre and chipboard.

271-7: Other paper products.

Since our interest lies in the study of the entire industry, we have, therefore, aggregated the data of all these subgroups together. The items covered in the CMI and ASI census schedules are given in Appendix 1 of this chapter. The inventory of items is long enough. We have, therefore, taken their aggregates and a few of them for the analysis presented in this study.

The CMI scheme was extended to the former Indian States on different dates after their accession to the Indian Union. Thus, factories situated in these States were excluded from the census before their accession but they were included after that. This affects the comparibility of the data over time. However, in the case of the paper industry these States did not have any paper mill before their accession, so the comparability of data is not affected by it.

The CMI and ASI schemes differ in coverage. Under the CMI scheme all the factories in 29 industries employing 20 or more workers each and using power were completely enumerated, but in the ASI scheme the factories employing 10 or more workers each with power and 20 or more workers without power were enumerated under two groups:

(a) Census Sector: Comprising the factories with 50 or more workers each and using power, and 100 or more workers without power. These factories were completely enumerated.

(b) Sample Sector: Comprising the factories employing 10 to 49 workers each and using power; and 20 to 99 workers without power. All these factories were covered on probability basis in the National Sample Survey scheme.

As mentioned earlier, the CMI scheme has covered the period 1946 to 1958 while the ASI scheme is covering the period 1959 onwards. A reliable single time series for the data covering the period of both the schemes can be had only when we know the additional statistics for the factories having 20 or more workers each without power which are not covered in the CMI census. The factories employing less than 20 workers and using power have already been covered in the CMI census (Ref: Table showing distribution of factories according to size of employment given in the CMI reports) although according to the explanatory note on coverage, given in the CMI reports, such factories should have been excluded from it. This is highly misleading. In view of this ambiguity and nonavailability of data for the factories employing 20 or more workers each without power for the years 1946-58, the best way is to take two timeseries, one for the CMI census period covering the years 1946-58 and another for the ASI census period i.e. from 1959 onwards. However, the problem of getting a single timeseries of the data for the paper industry covering the period 1946 to 1958 and 1959 onwards, is easier as their were no factories in operation or registered without power and having 20 or more workers during this period (Ref: Sample Survey of Manufacturing Industries reports for the years 1959 onwards).

The factories having less than 20 workers each and using power have already been covered in the CMI census which is evident from the tables showing the classification of the industry according the size of employment. The contribution of such factories was, almost, negligible so, even if we disregard them, the data series will not be affected significantly. For the purpose of having a long range timeseries of data for the industry, we have, therefore, directly linked the CMI and ASI series covering the periods 1946-58 and 1959 onwards respectively.

The percentage coverage of the number of factories enumerated in the census is given for each year in the CMI ASI reports. This information can be used to adjust the data series for 100% coverage, that is, for taking into account all the factories registered in the industry. This is an ideal procedure for the coverage adjustment of the factories are identical in size, otherwise it may give biased estimates. If a factory with size larger than the average size in the industry is left unaccounted in the census, the coverage adjustment for it would be under-estimated by using the percentage of the number of factories enumerated. On the other hand if the factory is smaller in size than the average size of factories, the coverage adjustment for it would be overestimated. This element of bias in the coverage adjustment for the industry can be reduced if the percentage of the total productive capacity

(instead of the number of factories) covered in the census, is used for this purpose. Since, the data on the productive capacity of the factories is not given in the CMI: ASI reports, we have to use the first procedure for the coverage adjustment in the data wherever it is required. The data given in the ASI (sample sector) reports already covers all the units in the sample sector of the industry, it is, therefore, added directly to the adjusted census data for covering the entire industry.

For some items of the input and output of the industry, the data is not exclusively given in the ASI sample sector reports. This, we have adjusted on the basis of the proportion between the sample and census sector values of the categories of input and output to which the items belong. For example, the value of the raw materials consumed in the sample sector of the industry was 10% of the census sector value in 1960. We have assumed this percentage for the individual raw materials such as bamboo, bagasse, waste paper and rags etc. There may be some discrepency in this adjustment but as compared to the values of the items for the entire industry it would be negligible.

Chapter 3,4,5 and 6 of this study are based on the CMI ASI data. In chapter 3, value and index series of the data covering some important aspects of the industry

have been used for the analysis of growth and structural changes. From the production data given in the CMI:ASI reports we have constructed the consumption series for fitting the demand functions for different categories of paper and paperboard in chapter 4. The analysis presented in this chapter covers the financial years rather than the calender years, so the production series obtained from the CMI and ASI reports have been adjusted accordingly. For fitting the production function shown in chapter 5, we have used the inputs and output data series from the CMI: ASI reports. In this chapter, we have used the data on output, capital, labour and material inputs, value added and wage rates etc. as it is given in the census reports. We have not adjusted it for 100% coverage of the factories because it was not required.

2.2 Additional Sources of Data:

In addition to the CMI: ASI data, we have used some other data series especially in the chapter of demand analysis. In this chapter, alternative consumption series were constructed for different categories of paper and paperboard for which the production data is taken from "Monthly Statistics of Production of Selected Industries" or "Journal of Industry and Trade". Both these journals are published by the Government of India. National income

statistics used in fitting the demand functions has been taken from the C.S.O. publications: 'Estimates of National Income 1948-49 to 1959-60'; and 'Revised Series for National Products 1964'. The income originating from the agriculture and domestic services has been deducted from the total national income to compute the 'nonfarm national income' series used in fitting the demand functions for industrial papers.

The data on number of students has been taken from the Government of India publications: 'India 1967' and 'Statistical Abstracts of Indian Union' for various years. In these reports the number of students is given only for the recognized institutions. The data on the number of students in non-recognized institutions is not available. We have, therefore, assumed that the growth in the number of students of non-recognized institutions was in the same proportion as the number of students of recognized institutions. The index series showing the growth in the number of students of recognized institutions, thus, represents the growth in the number of students of all institutions in the country.

The price indicies of different categories of paper and paperboard have been derived from their value and quantity statistics given in the CMI: ASI reports.

2.3 Measurement of Capital Input:

Capital is an important factor of production. There are some difficulties in its measurement for its use in fitting the production function of an industry. The stock of capital as we know, consists of various kinds of machines, equipment and tools, buildings and land etc., at different stages of their life cycles. A single physical measurement for all these heterogeneous capital items is difficult to find. Because of this difficulty the capital stock used in production is, generally, measured in value term which is then deflated by an index of prices. The ideal price index to be used for deflating the value of capital stock should reflect the changing value of capital services. Unfortunately such a series is not yet available, and instead, the convention is to deflate the value of capital stock by an index reflecting the changes in its 'price'. In some studies 'employment' and 'consumption of electricity' have been used as deflators for the capital stock. But there are some objections to this. Solow (1957) and Massel (1962) who used the 'employment' series, rightly admit that this is a crude approximation since it is based on somewhat unrealistic assumption of uniformity in the rates of growth of capital stock and employment in the industry. Use of the consumption of electricity is objectionable on the ground

that (1) consumption of electricity may differ with the age of equipment; (2) a large part of the electricity is used for non-productive purpose and (3) there may be changes in the techniques of production in the industry resulting in more and more use of power driven machines in place of hand driven one. This may cause disproportionate growth in the total capital stock and the part of it based on the electric power resulting in biased estimates of the total capitaliinput if 'consumption of electricity' is used as a deflator. In view of these objections, the index reflecting the changing price of capital stock, is a better deflator for its value.

In business accounting the value of capital stock is generally recorded in terms of the 'book value' at historic prices.. The book value being a cumulative sum of annual increments in the value of capital stock at different prices for the past years, may give inaccurate estimates of the capital input if deflated directly by the price index of a particular year. To avoid this, the normal procedure is to deflate the annual increments in the value of the capital stock by the price index. The cumulative sum of the deflated annual increments in the value of capital stock then gives the estimates of the capital input for different years. This procedure is called by the name of 'Perpetual Inventory' method suggested first by Goldsmith (1951). The main idea

behind this procedure is to convert the 'book value' into the 'current value' which can then be deflated by the price index of capital stock. There are some alternative techniques (Walter 1963, p.24) for measuring the current value of capital stock but they are rarely used now-a-days except the one described below.

The main problem in the perpetual inventory method is, regarding the starting values. If the full series of capital stock and its price are available right from the beginning of the industry,then there is no problem at all, but when they are not available for the past period then the problem of base value for maintaing the perpetual inventory becomes serious. There is no method to vaoid this difficulty. One may take any plausible figure of the right order of magnitude (Colin Clark, 1970). For example, the book value of capital stock may be taken as such for this purpose. Although doing so is not free from the bias in the inventory of the capital stock, but this may not matter seriously if the base value is small in magnitude. In view of this bias, the alternative convention for measuring the capital stock for the purpose of fitting a production function is to use the book value as given in the factory records. One may assume some kind of proportionality between current and book value of capital stock and thus, deflating the book value of

capital stock directly, can get a workable capital series for fitting the production function. Prof. Mahalanobis (1963) for example, in context of the planning model he developed, assumed the current value of capital stock as double of its book value. Although theoretical validity of 1:2 ratio between 'book' and 'current' values of fixed capital is very much doubtful since it is based on some what unrealistic assumptions such as 'a steady state' in the growth of capital stock and existence of a given type of equipment in large number with fixed life span. Nevertheless this may be used as a crude approximation in the absence of a better capital series.

As mentioned earlier, the concept of capital stock we should employ in production function should correspond to the 'capital services' provided. For this, the concept of gross fixed capital is more appropriate since the machines, buidlings and land etc., give identical capital services over their life span what ever be their net worth (Walters, 1963, P. 23-24). However, the gross fixed capital should be amended to take into account not the decline in value but the decline in efficiency of a piece of equipment as it ages. In business accounting the data on physical depreciation of the capital equipment is not accounted separately because of the difficulties associated with its measurement. The normal practice is,

therefore, to deduct the entire amount of depriciation as it is given in the factory records from the gross value of fixed capital. In other words, the net value of fixed capital is conventionally used as a measure of the capital input for fitting the production functions.

To fit the production function for the Indian paper industry we have followed the perpetual inventory method for measuring the capital input. Alternatively, we have deflated the book value of capitcal stock directly to get the capital series. This was needed since the CMI: ASI reports from which the capital stock figures have been taken, do not specify clearly whether they are at historic prices or at current prices. The explanatory note regarding this merely says: "the value of capital items is taken as in the books of the factory". Normally in factory records the value of fixed capital stock is given at historic prices so we have presumed that the CMI: ASI census figures on fixed capital stock are at historic prices, though, in the absence of proof this is doubtful. Because of this doubt, we are forced to use the alternative procedure for obtaining the capital series.

For maintaining the perpetual inventory of fixed capital the year 1949 is choosen as the starting year. We could not go earlier than this because of the

non-availability of price indices for deflating the capital stock, although capital figures are available from the year 1946. The value of fixed capital stock obtained from the CMI: ASI reports for the year 1949-64 was amended first for 100% coverage. Then the perpetual inventory was maintain for it at 1952 prices by deflating the annual increments by an index of prices especially constructed for this purpose. No change has been made in the value of fixed capital for the starting year 1949. It is assumed to be at current prices. The deflated capital series thus obtained, was brought back to the original coverage as given in the CMI: ASI reports. We have preferred to do so instead of amending the output, labour, materials and fuel consumption series used in estimation of the production functions for 100% coverage since it was not necessary. This capital series and the one obtained by deflating the book value of fixed capital directly, were then multiplied by the 'capital-utilization factor' to remove the content of idle capacity from them. The ratio between the actual output and total capacity of production of the industry, has been used as the 'capital-utilization factor'.

In the CMI: ASI reports it is not explicitly mentioned whether the value of fixed capital is 'net' or 'gross', but, a perusal of the table for 'capital structure'

given in the appendix of the CMI reports reveals that it is 'net'. In ASI reports the explanatory note regarding this is highly confusing, so we have presumed that the capital figures given in these reports are also net of depreciation. However, whether the figures on capital stock in the CMI: ASI reports are 'gross' or 'net' of depreciation, is not a matter of serious consideration. It would hardly affect the production function since with the use of the 'straight line' procedure to estimate the depreciation as done in the CMI ASI reports, there would be a proportionality between 'gross' and 'net' value of fixed capital.

In cross-sectional studies of the production function undeflated capital series (gross or net) can be used, but, in the case of time series studies this would be a wrong procedure since such series would not be independent of the variation in the prices of the capital equipment. The gross book value of fixed capital can, of course, be taken as a measure of capital input if all other data series such as labour, materials and output, are also taken in value terms and prices of all inputs and output vary proportionately, otherwise it will give biased estimate of the production function. We have, infact, tested this by fitting the production function for the industry using

the gross and net undeflated book values of fixed capital. The results were not satisfactory as compared with other fits.

Three shifts working day has been assumed for the industry. The capital series measured above, have, therefore, been multiplied by a 'shift factor' equal to 2.7 as suggested by the N.C.A.E.R (1966, Page 9.)

In symbolic form the procedure for constructing the capital series for fitting the production function can be expressed as:

let k be the deflated value of fixed capital (gross or net),
b be the 'capital utilization factor'
and 2.7 is the shift factor for 3 shifts working day, the value of the fixed capital used in production would then be:

$$K = 2.7 \times b \times k$$

Following this procedure, we have derived the following three alternative estimates of the capital input for fitting the production functions for the Indian paper industry.

1. Net Fixed Capital: Book Value Undeflated
2. Net Fixed Capital: Book Value Deflated
3. Net Fixed Capital: Current Value Deflated

The selection of the best among these three alternative series is left to the empirical results, but it should be from the last two series in which the price escalation effect from the value of capital stock is removed by deflating them. However, for some types of production function the undeflated capital series may be used, as we will see later on in chapter 5 of this study.

The price index used for deflating the capital series has been constructed as follows. For the value of 'plant, machinery and other equipment' we have used the price index of 'machinery and other equipment' as given in the Government of India publication: "Index Numbers of Wholesales Prices in India" (Office of The Eco. Adviser) or Reserve Bank of India Bulletins. For the value of 'land, building and other fixed assets' we have used the general price index. The price indices compiled by the C.S.O (1962) and Reserve Bank of India (Shukla, 1965, Page 137) have also been used to deflate the value of 'land, buildings etc', but the series obtained were almost similar as given by the general price index. However, we could not use them in the analysis of the production function since they covered the period upto 1960 only, while this study covers the period upto 1964. Combining the 'general price index' and the price index for 'machinery and other equipment', we have constructed a

weighted price index for deflating the value of fixed capital stock. The percentage shares of the two components of fixed capital i.e. 'land and buildings etc.' and 'plant and machinery', were used as weights for this purpose.

2.4 'Output', 'Value-Added', 'Labour' & 'Material Consumption' Series:

All these series required for fitting the production function for the Indian paper industry have been taken from the CMI: ASI reports. 'Output' series represents the ex-factory value of products & by-products manufactured, products under process and 'work done for consumers'. The price index series of paper and paper-board has been used to deflate it or convert into quantity terms. Two labour series have been used in estimation of the production function. One is the 'number of persons' employed in the industry and second is the 'number of manhours worked' by the workers. For computational ease, 'manhours' have been converted into 'manyears' assuming 8 hours working day and 300 days in a year. 'Material consumption' series includes deflated values of fuel and power etc., basic materials, chemicals and packaging materials. The 'value added' series represents the difference between deflated values of 'output' and gross material inputs.

2.5 Derivation of Consumption Series for Different Categories of Paper and Paperboard:

For the analysis of the demand for paper and paperboard in India, we need consumption data for its different categories such as newsprint, other printing and writing papers, wrapping and miscellaneous papers and paperboard. Readymade figures of these are not available. The input-output studies have thrown some figures, but they are available only for a few isolated years. To estimate the consumption figures for different categories of paper and paperboard we have, therefore, followed the following procedure.

Consumption = Production + Imports - Exports + (Initial Stock - Terminating Stocks)

For each category of paper and paperboard, production and trade figures are avilable on annual basis, but the information regarding the stocks is very scanty. The CMI: ASI reports and other Government publications such as 'Monthly Statistical Abstracts' and 'Reserve Bank of India Bulletins' give figures regarding the stocks of paper and paperboard with the industry, but it is not given categorywise. The figures on stocks of paper and paperboard with the traders are not available at all. From the stocks figures given in the CMI: ASI reports and other publications we find extremely low changes in the net stocks of paper and paperboard as compared with

the total consumption of it which can, therefore, be discarded (Ref. Table 4.20 Ch. 4). Because of the negligible changes in the net stocks of total paper and paperboard with the industry and nonavailability of stocks data with the traders as well as for different categories of paper and paperboard, the consumption figures used in the demand analysis given in chapter 4, include only production and foreign trade statistics. In other words, they are the figures of apparent consumption. Further, export of paper paperboard from India was almost negligible during the period under review (1950-1965). Thus our consumption figures are equivalent to annual production plus annual imports only.

For production data we have two sources in India. The CMI: ASI reports and the 'Monthly Statistics of Production of Selected Industries' reports. The CMI: ASI reports give production figures for the entire industry but in 'Monthly Statistics of Production' reports only large scale organized units are covered. From these two different sources of production data for the industry, we have derived two alternative consumption series for each category of paper and paperboard. The consumption series based on the CMI: ASI production figures may be called as '<u>CMI: ASI series</u>' and the one based on the Monthly Statistics of Production data may be called as '<u>M.S.P.S.</u>

Series' (M.S.P.S. is the abbreviated term for Monthly Statistics of Production of Selected Industries). Since the CMI: ASI series covers the entire industry, it will be mainly used in the econometric analysis of the demand for paper and paperboard to be presented in Chapter 4. In planning, for which current data is required, the CMI: ASI data series (now of course ASI: series only) are rarely used because of the time lag (of 3 to 5 years) in their availability. The M.S.P.S. series, being available for the current period are generally used for this purpose. Therefore, along with the CMI: ASI series we will also use the M.S.P.S. series for estimating the demand functions for different categories of paper and paperboard in India.

2.6 Data Tables:

The data tables are given at the end of chapters 3,4,5 and 6. Chapter 3 contains most of the data tables on input-output structure of the Indian paper industry for the period 1948 to 1964. Chapter 4 contains the data tables related to the consumption of different categories of paper and paperboard in India; national income and number of students etc.. In chapters 5 and 6 the data tables contain the series used in estimation of the production and cost functions

Table 2.2

Selected Items of Data for Sample and Census Sectors of Indian Paper Industry (1959-64)

Item	1959	1960	1961	1962	1963	1964
1. Fixed Capital (Rs. 000)						
Sample Sector	10090	10953	11393	22284	19538	NA
Census Sector	361929	490233	496168	635017	755854	NA
Sample Sector as % of Census Sector	2.8%	2.3%	2.3%	3.5%	2.5%	2.0%**
2. No. of Workers						
Sample Sector	3000	3763	3100	4558	4520	NA
Census Sector	32848	40080	40299	43204	47144	NA
Sample Sector as % of Census Sector	9.1%	9.4%	7.2%	10.1%	9.6%	10%**
3. Value of Fuel & Power (Rs,000)						
Sample Sector	889	826	530	1554	1379	NA
Census Sector	51561	64591	71414	79294	101198	NA
Sample Sector as % of Census Sector	1.7%	1.27%	0.8%	1.9%	1.36%	1.5%**
4. Total Materials Consumed(Rs,000)						
Sample Sector	30470	33100	44703	46252	50741	NA
Census Sector	282148	325746	364548	411715	480607	NA
Sample Sector as % of Census Sector	10.6%	10.1%	12.2%	11.2%	10.6%	10%**
5. Total Output (Rs,000)						
Sample Sector	43730	45234	47750	62583	72156	NA
Census Sector	551351	619958	682477	771997	936123	NA
Sample Sector as % of Census Sector	7.1%	7.3%	7.0%	8.1%	7.7%	8%
6. Value Added(Rs,000)						
Sampe Sector	12030*	10053	12950	16331	17262	NA
Census Sector	171750	171398	185153	217349	262471	NA
Sampe Sector as % of Census Sector	7%	6.0%	6.9%	7.0%	7.0%	7%**
7. No.of Sample (For Sample Sector)	64	66	63	61	84	NA
Universe of sample	NA	149	160	NA	196	NA

*Estimated. **Assumed Value: NA = Not Available
Source:Govt.of India(CSO) ASI Sample & Census Sector Reports 1959-64.

APPENDIX 2.1

NOTES ON TERMS USED IN CMI AND ASI REPORTS

I. Registered Factories:

In CMI scheme a factory employing 20 or more workers and using power was taken as a census unit. In ASI scheme factories employing 50 or more workers and using power or 100 or more workers without power were completely enumerated and factories employing 10 to 49 workers with power and 20 to 99 workers without power were enumerated on probability sample basis.

II. Average Number of Working Days:

In both, the CMI and ASI schemes, 'average number of days worked' was computed by adding the number of days worked by the factories in the State or industry as the case may be, and dividing the aggregate by the number of factories which worked during the year.

III. Productive Capital:

In both, the CMI and ASI schemes, capital employed in production relates to 31st December of the year under census. It consits of <u>fixed</u> and <u>working</u> capital. Fixed capital comprises of land, buildings including those under construction, improvements to land and other

construction; plant, machinery and tools; transport equipment; other fixed assets such as furniture, fixtures, etc., and intangible assets. Working capital consists of stocks of materials, stores, fuels, semifinished goods including workin-progress and finished products and byproducts; cash in hand and at the bank and the algebric sum of sundry credits as represented by (a) outstanding factory payments e.g. rent, wages, interest and dividents; (b) purchase of goods and services; (c) short terms loan and advances and sundry debtors comprising amounts due to the factory on account of sale of goods and services and advances towards purchase and tax payment. Long terms loans and debentures including advances by proprietors and working partners were excluded.

The value of capital item was taken as in the books of the factory. In the case of rented capital, 12 times of the rent was added as its value to the total productive capital employed in production.

IV. Number of Persons Employed:

In both ,the CMI and ASI schemes, the average number of persons employed by each factory under various heads such as workers, other than workers etc., was computed by taking the attendance of persons in all the shifts on all working days and dividing it by the number

of days worked. The averages were aggregated for all factories in the State or industry as the case may be, and the aggregate was taken as the number of persons employed in the State or industry, respectively. It includes persons attending and on leave with pay, such as sick leave, casual leave or paid vacation and also those engaged in welfare activities.

V. <u>Workers</u>:

The term 'workers' is used in the same sense as in the Factories Act 1948 in both the CMI and ASI schemes. It excludes persons holding positions of supervision and management or employed in confidential position. Section 2(I) of the Factories Act, 1948 defines 'worker' as a person employed directly or through any agency whether for wages or not, in any manufacturing process or in cleaning any part of the machinery or premises used for a manufacturing process or in any other kind of work incidential to or connected with the manufacturing process.

VI. <u>Persons Other Than Workers</u>:

This term includes all employees other than workers as defined in V. above.

VII. <u>Manhours Worked</u>:

The number of manhours worked during a particular

year was computed by multiplying the number of workers employed in each shift by the number of hours in the shift and aggregating the products for all shifts on all working days. The number of manhours for State or an industry was taken as the number of manhours worked by all factories in that State or industry.

VIII. Salaries and Wages:

In both, the CMI and ASI schemes, the term "Salaries and Wages" includes all payments made in cash as compensation for work done during the year, e.g., basic wages, dearness allowance, overtime payments, shift allowance, leave wages, wages for paid holidays, all bonuses such as profit-sharing bonus, production bonus, good attendance bonus, incentive bonus, etc., and other cash payment made from time to time regular and adhoc, contractual or ex-gratia.

IX. Money Value of Benefits:

This includes the cost value or the net cost of the concession in respect of supplies made or services rendered such as housing, foodgrains, medical, educational, transport, recreational facilities etc., payments by way of pensions, gratuity, retrenchment and lay-off benefits; compensation for work injuries and occupational diseases, maternity and sickness benefits, employers'

contributions to provident fund and State Insurance etc.

X. Materials and Fuels Consumed:

In both the CMI and ASI schemes this item excludes any fuel or material manufactured within the factory and consumed in it, e.g., electrical energy generated and consumed within the factory. The coal used in generating the energy was, however, included since it was brought into the factory from outside. Materials consumed for repairs and maintenance were included. The value of materials, etc., consumed was the cost at factory. It includes the purchase price, transport charges and other incidental costs.

XI. Work Done by Other Concerns or Industrial Services Purchased:

This comprises work done by other concerns on repair and mainteancne as also manufacturing work done on material given out to them. The cost of industrial services purchased is inclusive of any transport and other charges incurred in this connection.

XII. Inward Transportation Charges, Purchase Agency Services, etc.:

This item represents total incidental expenditure on the purchase of materials, etc., such

as cost of transport, purchase agency commision, taxes and duties paid, etc., which could not be included in the purchase value of any individual item of materials, etc. It also includes postage, stationary and printing expenses.

XIII. Gross Material Input:

It is the gross value of materials and fuels, etc. consumed, work done by other concerns, products reported for sale last year but used for further manufacture, incidental expenditure on purchase of material etc., non-industrial services purchased, depreciation and purchase value of goods sold in the same condition as purchased. Non-industrial services purchased include amounts paid for auditing, bank charges, legal expenses, insurance charges, local rates and factory licences, etc.

XIV. Depreciation:

Prior to 1960, depreciation was calculated at the rates allowed by the income tax authorities for assessing the taxable income. Since 1960 'straight line' depreciation was reported in the ASI census. The formula used for calculating the depreciation amount was:

$d = \frac{a-b}{c}$ where 'd' is the depreciation amount; 'a' is the installation cost; 'b' is the estimated scrap

value and 'c' is an estimate of the working life of the asset in question.

XV. Value of Products and By-Products:

It represents the value of products and by-products manufactured for sales during the year. The value is ex-factory, i.e., exclusive of any incidental expenditure on sales. Products consumed for further manufacture in the factory are excluded.

XVI. Work Done for Consumers or Industrial Services Sold:

It comprises work done by the factory for other concerns on repairs and maintenance as also manufacturing work done on materials supplied by the latter. The value is net of any discount or rebate and other draw backs allowed to customers, and payments for carriage outward.

XVII. Gross Output:

It is the aggregate value of products and by-products manufactured for sales, work done for customers, and sale value of goods sold in the same condition as purchased, and is adjusted for the difference in stocks of semi-finished goods at the beginning and at the end of the survey year.

XVIII. Value Added by Manufacture:

This represents that part of the value of products

which is created in the factory and is computed by deducting the gross material input from the gross output of the factory.

CHAPTER 3

TRENDS IN INPUT - OUTPUT STRUCTURE OF INDIAN PAPER INDUSTRY, 1948-1964

We are now in a position to start our econometric study of the Indian paper industry. In context of this study, it is, however, better to familiarise ourselves at the outset with the salient features of the growth and changes in the input-output structure of the industry that occured during the period under review. This understanding will be useful for interpreting the results of the econometric analysis given in chapters 4,5 and 6. For example, from the trends in the growth of capital and labour and their relative shares in the output of the industry, we will have a fairly good idea regarding the output elasticities with respect to these factors of production and the elasticity of substitution between them. Moreover, through the analysis of the historical trends in different categories of inputs and output, we will be able to bring out the changes in their composition and hence, of the technological structure of the industry for the period under review. This is the subject matter for discucssion in this chapter. The chapter is arranged under four sub-headings, viz. (1) 'Input Structure', (2) 'Output Structure', (3) 'Trends in Average Productivity of

Inputs and Technological Structure of the Industry' and (4) 'Summary of the Chapter and Conclusions.'

3.1 Input Structure:

Conventionally, the inputs used in manufacturing are classified into four distinct categories, viz. Capital, labour, fuel and power and materials. For the purpose of studying the changes in the input structure of the paper industry in India these four categories of inputs will be analyzed separately. The basic data required for this purpose have been taken from the CMI: ASI reports details of which are given in Chapter 2 of this study.

3.1.1 Productive Capital:

In the CMI: ASI reports from which the data have been taken for this analysis, the total value of capital employed in production is given under the heading 'productive capital'. It consists of the fixed capital, comprising the factory land and buildings; plant, machinery and miscellaneous tools; transport equipment; furniture, fixtures, fittings, patents, and trade marks; and the working capital comprising the stocks of raw materials, finished and semi-finished products, cash in hand and at the banks and current credits. The word 'productive' attached with 'capital' is redundant because, capital itself cannotes its productivity

otherwise it can't be called as capital.

In Table 3.4 given in appendix of this chapter, we have presented some important capital series of the paper industry of India covering the period 1948 to 1964. Each capital series is given in terms of value (Rs. Lakh) and index form with 1948 as the base year. The fixed capital is expressed in terms of its book value, but the working capital is in terms of current value. The total productive capital is, therefore, a weighted sum of the book value of fixed capital and current value of working capital.

As the table shows, the total productive capital employed in the paper industry of India has increased from Rs. 911 Lakhs in 1948 to Rs. 12674 Lakhs in 1964 showing 1291% growth at the rate of 16.75% per year. During this period the growth in the fixed capital was 1546%. It has increased from Rs. 596 Lakhs in 1948 to Rs. 9822 Lakhs in 1964 with a cumulative growth rate of 17.91% per year. The growth of the working capital during the period 1948-1964 was slower than in the fixed capital. By 1964 the increase in the working capital was only 807% over its 1948 level (Rs. 314 Lakhs). The annual growth of the working capital was 13.85%. The percentage share of the fixed capital in the total productive capital has shown a rising trend during the period 1948-64. From

1948 to 1956 its range of variation was between 59 to 67% but later on it has shifted to 67 to 81%. During the II and III Five Year Plan period the industry has expanded very rapidly. The new paper mills established during this period might have been operating initially below their capacity level having high investment on the fixed capital but comparatively low investment in the form of working capital and thus, a rising trend in the share of the fixed capital in the total productive capital was not surprising.

From the point of view of growth, increase in the fixed capital formation is highly relevant for a capital intensive industry like pulp and paper. We have seen above that the growth of the fixed capital employed in the paper industry of India was quite impressive during the period 1948-64 (1546%). Further examination of this reveals that the total value of 'plant, machinery and tools' which constitute a major part of the fixed capital, has increase by 2196% in 16 years since 1948 with a cumulative rate of 19.93% per year. At the same time growth in the total value of 'land, building and other fixed assets' which constitute the second part of the fixed capital was only 920% or 13.95% per year (Ref: Table 3.4 Col. 12 to 19). The percentage share of the 'plant, machinery etc.' in the total fixed

capital was found to be increasing gradually since 1948. It was around 57% in 1948 but increased to 76% in 1964.

From the analysis of the value series, we do not get a true picture of the growth in capital input. The value might have been escalated by the increase in prices of the capital items. To have an idea of the growth in the quantity of the fixed capital employed in the industry during the period 1948-64, we have kept the prices at constant level by deflating the series with the suitable price indicies (Ref: Page 49 Ch. 2 of this study). The deflated series for the total fixed capital and one of its constituents are shown in Table 3.4. From these series we find an increase of 1000% in the total fixed capital (in real terms) and 1300% in the 'plant and machinery' part of it during the period 1948-1964. From 1948 to 1964, growth in the total productive capacity of the industry was about 700%. Thus, in comparison with the growth of the productive capacity, growth in the fixed capital employed in the paper industry of India was higher during the period 1948-64. This shows that by the end of the year 1964, the industry was more capital intensive than it was in 1948.

3.1.2 Labour:

Since 1948, the growth of the employment in the paper industry of India has been too slow in comparison with that in the fixed capital or in the productive capacity of the industry. Where the real fixed capital employed in the industry has increased by more than 1000% during the period 1948-64 and the capacity of production by about 700%, the growth in the total number of persons employed was only 193% (Ref: Table 3.5 A). From 1948 to 1964 the increase in the number of workers was 173%. Compared to this the increase in the number of 'non-workers' was moderately high (350%). The growth in the total number of manhours worked was also higher (202%) than that of workers during this period. The annual growth of the total number of persons employed in the industry was 6.5%; workers, 6.1%; 'non-workers, 9.2% and the total number of manhours worked 6.7%,during the period 1948-64. Because of the higher growth in the number of 'non-workers', the percentage share of the workers in total number of persons employed in the industry declined from 89% in 1948 to 83% in 1964. The slow growth of the employment in the industry during the period under study was not surprising. We know that the industry has a strong tendency to become more and more capital intensive. Since labour and capital are in general, substitutes for

each other, the quantity of labour is likely to decrease with increase in capital. From 1948 to 1964, production of paper and paperboard has increased by 600% as compared to 202% increase in manhours worked and about 1000% increase in the fixed capital. This shows clearly the growing capital intensity in the paper industry of India.

As we have seen above, the growth in the number of nonworkers was faster than that of workers in the industry during the period 1948-64. Increasing capital intensity of the industry was a main reason for this. Among the nonworkers we include managers, engineers, technicians, clerks, accountants and salesmen etc. The number of such persons increases as level of the output increases. Also, as the amount of capital increases, more and more men are required to man it. Over all there should be a buoyancy in the rate of growth of actual output and the rate of growth of 'non-workers'. In a slightly different way we can say that in a capital intensive industry like pulp and paper, the percentage of the 'non-workers' in the total member of persons employed increases with the growth of the capital.

In Table 3.5B the financial side of the labour input is given. The average earnings of the

persons employed in the industry was Rs. 982 per annum in 1948. It has increased to Rs. 2340 in 1964. Similarly, the average wage of the workers has increased from Rs. 768 to Rs. 1678 per annum, and the average salary of the nonworkers from Rs. 2407 to Rs. 4325 per annum during the period 1948-1964. The increase was about 2.4 times in the 'average earnings', 2.2 times in the 'average wage' and 1.8 times in the 'average salary'. The average wage per manhour worked was double (Rs. 0.60) of 1948 level (Rs. 0.30) in 1964. 'Real' values of the average earnings and 'average wage' (see figures in brackets) were increasing but very slowly. The increase in 1964 over the 1948 level was around 1.5 times in both.

Thus, seeing the past trends in various labour series (total number of persons employed, workers, nonworkers, and their total wages, salaries, average earnings, etc.), we find little scope for the employment in the paper industry. As the industry is expanding, the significance of the labour is declining gradually.

3.1.3 Fuel, Power and Lubricants, etc:

In India, paper industry is using almost all the sources of energy like coal, coke, coal gas, wood fuel oils, natural gas and electricity. Among them,

coal, fuel oils and electricity together account for more than 90% of the industry's total energy requirements. On the basis of the percentage distribution of the total expenditure on 'fuel, power and lubricants etc' by source for years 1948-64 (Ref: Table 3.6A), we find that use of coal as a source of energy is declining while that of fuel oils and electricity is increasing. In 1948 the share of the expenditure on coal in the total expenditure on fuel, power and lubricants' was 72.10% which dropped to 67.04% in 1950, but again increased to 75.3% in 1951. Since 1952 it has been declining continuously. In 1964 it was 47.88% showing a drop of 24% in 16 years. On the other hand, the share of the expenditure on electricity has increased from 13.5% in 1948 to 30.5% in 1964. Similarly, the share of fuel oils has also increased from 4.7% in 1948 to 10.9% in 1964. The percentage share of the expenditure on lubricants was declining gradually. It was around 3.5% between 1948-54 but later on gradually dropped to 2% in 1964. The percentage share of the expenditure on miscellaneous fuel items such as coke, charcoal, coal gas, wood, water, etc., was 6 to 8% between 1948-50 but later on it has dropped to 1 to 4%.

We know, the share of a source in the total expenditure may very by changes in its quantity and the

price. Prices of coal, fuel oils, lubricants and electricity, etc., were, of course, rising since 1948 (Ref: Table 3.6D) but their quantities have changed in greater proportions. As compared with the 1948 level, the quantity of coal consumed in 1964 was 247% higher, similarly, the consumption of fuel oils and electricity was 1478% and 1351% higher respectively in 1964 over their 1948 levels. The annual growth in the consumption of coal, fuel oils and electricity during the period 1948-64 was 7.6%, 17.6% and 17.0% respectively. On the basis of these growth rates we can conclude the use of coal and other traditional sources of energy is declining rapidly in the paper industry and the use of fuel oils and electricity is increasing. This trend is obviously common in all industries. Fuel oils and electricity are technically better sources of energy than coal. In India on account of the rising transportation costs and diminishing stocks of coal, new industrial units are mainly based on electric power and fuel oils for which the future prospects of supply are better.

As we have seen earlier, annual growth in the 'plant and machinery' employed in the industry was 16.8% during the period 1948-64. The annual growth in the consumption of fuel oils (17.6%) and electricity (17.0) was, thus, consistent with the growth in the plant and

machinery, during the period 1948-64, but the growth in the consumption of coal was far behind. The similarity in the growth rates of the 'plant and machinery' and consumption of fuel oils and electricity, itself indicates the dependence of new paper mills on electricity and fuel oils for energy.

3.1.4 Raw Materials:

In India the basic raw materials used for the manufacture of paper are bamboo, wood, grass, rags, waste paper, bagasse, straw, hemp ropes, jute waste and hessian cuttings. Bamboo and other varieties of wood constitute the bulk of raw materials for the industry but their quality is not very good. They come in the category of 'hardwoods' having short fibres and thus, are suitable only for the low grade paper. Due to tropical climate here in this country, we do not have 'shoft woods' of the type available in North America, Sweden, Finland and other paper producing countries, where infact, availability of the shoft woods for paper making is a factor for high growth of the industry.

Since 1948, Indian paper industry is in a phase of rapid development. Consequently the demand for raw materials has been increasing since then. In

1948, the annual consumption of five major fibrous raw materials: pulp, grass, bamboo, waste paper and bagasse was 3.1, 51.4, 117.1, 25.1 and 9.2 thousand tons respectively. In 1964 the annual consumption of these materials was 41.1, 88.2, 999.7, 108.2 and 78.2 thousand tons respectively (Ref: Table 3.7A). Thus between 1948-64, growth in the annual consumption of these five raw materials was 1385%, 72%, 332% and 751% respectively. The corresponding growth in the total value of these five raw materials was 1516%, 116.6%, 800%, 659% and 2721% respectively (Ref: Table 3.7B). Growth in the annual consumption of other fibrous raw materials such as wood, rags, straw, and jute waste, etc., was also highly remarkable during the period 1948-64 (Ref: CMI, ASI Reports).

Along with the rapid growth of the industry during the period 1948-64, there were some important changes in its raw materials consumption pattern. From the percentage distribution of the total value of basic raw materials given in Table 3.7C, we find a downward trend in the percentage shares of pulp (readymade) expect for years 1948-51, grass and bamboo. Bamboo being a major source of fibre for the industry was having 35.3% share in 1948 which came down to 25.9% in 1964. In the case of waste paper, there was a decline in its percentage share during

the period 1948-52 but in the next four years (1953-1956) it was rising and from 1957 onward there was again a declining trend, inspite of its rising prices. The percentage share of bagasse in the total value of basic materials was extremely low (0.6 to 2%) during the period 1948-64 though it was showing a rising trend. In the percentage share of'rags and other raw material' there was a rapid increase during the period 1948-64. In 1948 it was 17.6% which increased to 46.0% in 1964.

So far we have discussed only the growth or changes in the consumption of basic raw materials. Besides these, the industry consumes a large number of chemicals such as caustic soda, lime, alum, bleaching powder, rosin, dyes, acids and sodium sulphite, etc., for various purposes in manufacturing paper and paperboard. We will not go into details of the growth in consumption of each of these chemicals but will report briefly the growth or change in their aggregate value both at current and constant prices. Similarly packaging and other consumable materials will also be taken up in the study because they have their own place in the material input of the industry.

During the period 1948-64, growth in the aggregate value of the four categories of material inputs was as given in Table 3.1.

Table 3.1

Consumption of Materials in Indian Paper Industry
A Summary

Category of Materials	TOTAL VALUE (Rs. Lakhs) 1948	1964	Growth During 1948-64 %
1. Basic Materials			
(a) at current prices	274.5	3373.1	1128.7%
(b) at 1952 prices	332.1	2577.1	676.1%
2. Chemicals			
(a) at current prices	167.9	1728.8	929.6%
(b) at 1952 prices	238.4	1394.3	484.8%
3. Packaging & other consumable stores			
(a) at current prices	84.5	759.1	798.2%
4. Total value of Materials at current prices	526.9	5861.0	1012.2%
5. Inward Transport Cost of Materials, commission to purchasing agent etc.	0.38	102.56	26889.8%
6. TOTAL value of Materials at factory ((4) + (5))	527.3	5963.5	1030.9%

From this table we find that during the period under review maximum growth was in the value of basic materials both at current and constant prices as compared with the other two categories of material inputs viz.,

chemicals and packaging and consumable stores. The increase in the inward transportation cost of materials etc. (item 5) was far greater in comparison with the value of materials. Rising costs of the basic raw materials and explosive increase in the inward transportation costs were the two important factors for the high growth of the aggregate material cost (at factory) in the industry during the period 1948-64. In Table 3.80 we have presented the percentage distribution of the total material costs at factory among its four constituents, viz., basic materials, chemicals, packaging materials, and inward transportation costs covering the period 1948-64. From the table we find a rising trend in the percentage shares of basic materials and inward transportation costs. The percentage share of basic materials was 52.06% in 1948. Which increased to 56.56% in 1964. Similarly, though very small, the percentage share of inward transport costs etc. was 0.07% in 1948 which increased to 1.72% in 1964. On the other hand, we find a downward trend in the percentage shares of chemicals and packaging materials. In 1948 the percentage share of chemicals was 31.84% which declined to 28.99% and similarly, the percentage share of packaging materials declined from 16.03% in 1948 to 12.73% in 1964. Increase in the percentage share

of basic raw materials during the period 1948-64 was not surprising since both, quantity and prices of these materials were increasing with faster rates than that of chemicals and packaging materials (Ref: Tables 3.7B and 3.8C).

3.2 Output Structure:

3.2.1 Paper and Paperboard (Excluding Newsprint):

Paper is a heterogeneous commodity. It has several varieties with different characteristics and uses. On the basis of use all the varieties are generally grouped into five distinct categories. These are: (1) printing and writing paper; (2) wrapping paper; (3) miscellaneous papers; (4) paperboard, and (5) Newsprint. In each category except newsprint, there are many brands of paper or paperboard (See Appendix 1.1 Chapter 1). In the following pages we shall be studying the trends in the output of these different categories of paper and paperboard.

India is producing almost all the varieties of paper and paperboard required for domestic consumption. A substantial amount of paper consisting of some special

grades and newsprint is still being imported from abroad. In domestic production of paper and paerboard (except newsprint) printing and writing paper had a share of 47 to 60 percent, wrapping paper 8 to 15 percent other varieties 2 to 10 percent and board 27 to 34 percent, during the period 1948-64 (Ref: Table 3.9A). In value terms the range of variation of the percentage shares of these four categories of paper and paperboard was 52% to 65%, 8% to 15%, 4% to 13% and 17% to 25% respectively. Comparing the range of variation in the percentage share of each category of paper in value terms, with its range of variation in quantity terms, we find higher levels for 'printing and writing papers' and 'other varieties', almost constant level for 'wrapping papers' and a lower level for boards. This was the effect of their price differences. For 'printing and writing papers' and 'other varieties' prices were high so their relative shares went up in value terms while the prices of wrapping papers and boards were low so they had same or lower shares. In both the cases (value and quantity terms) there were fluctuations in the relative shares of each category of paper and paperboard. No definite trend has emerged in any oneof them. Generally, one should expect a declining trend in the share of printing and writing papers and a rising trend in the shares of all other categories as business and industrial

sectors of the economy expand. This is because wrapping papers, paperboard and other varieties of paper are mostly used in the industrial or business sectors of the economy. So consumption of these papers increases with the growth of the business and industrial sectors. However, a falling trend in the share of 'printing and writing papers' is possible only when 100% literacy has been achieved and population remains fairly constant as is happening in the U.S.A. and some of the European countries. In India, literacy level is too low, population is rising, education is spreading, so we do not expect a falling trend in the share of the printing and writing papers for at least coming few decades. Demand and production of other categories of paper and paperboard may also increase due to spread of business and industrial sectors here in India. So the output structure of the industry is likely to be stable during the next few years.

In India, production of printing and writing papers increased at the rate of 11.38% per annum during the period 1948-64. In 1948, the total production of printing and writing paper was 56.6 thousand tons which increased to 357.7 thousand tons in 1964 showing 524.7% growth. Similarly, the production of wrapping papers, 'other varieties' and board was 258%, 803% and 392% respectively higher in 1964 over their 1948 levels

(Ref: Tables 3.9B and 3.9C). Growth in the production of 'other varieties' of paper was maximum, because, these are mostly industrial papers such as cigarette tissue, currency paper, and crome papers, etc., for which demand prospects are very high in India. Growth in the production of wrapping papers and paperboard was comparatively lower than that of other two categories of paper and paperboard, viz. printing and writing papers and 'other varieties'. Growth in the total production of all four categories of paper and paperboard during the period 1948-64 was 450% of its 1948 level.

As compared with the quantity, increase in the value of output of different categories of paper and paperboard was higher during the period 1948-64 because of their rising prices (Ref: Table 3.9B). Although prices of the common varieties of paper and paperboard were controlled voluntarily by the mill owners during the period 1948-57 and by the Government since January 1, 1960, yet there were rising trends in the aggregate prices of different categories of paper and paperboard during the period 1948-64 (Ref: Table 3.9D). Because of this, the value of output was natural to grow faster than the quantity during this period.

3.2.2 Newsprint:

We know, newspapers and periodicals are traditional mass-media of communication. Circulation of newspapers and periodicals mainly depends upon the mass-literacy, spread of business sector, absence of low period alternative means of communication and living standards of the masses. All these factors make the newspaper demand a rising function of the overall socioeconomic development of a nation. The important factor which makes newspaper as the most successful mass-media is its cheapness. Prices of newspapers are kept low so that readers with low income can also purchase them. Low price means low cost of production. Since price of newsprint is an important part of the cost of production of newspaper, so it has to be kept low. Low price of newsprint is possible only when it is produced on a very large scale as is being done in Canada, Finland and Sweden which are top newsprint exporting countries in the world. Large scale production of newsprint at cheap price technically depends on the availability of soft wood long fibred raw materials. Such raw material resources are limited in most of the countries of the world except Canada, U.S.A., Sweden, Finland and Norway.

In India, non-availability of the suitable raw materials for newsprint is the main hurdle in its mass

production. Paper manufacturers in India are reluctant to produce newsprint because of its low profitability. Moreover it requires a large investment on fixed plant initially which is beyond the capacity of average mill owners here in India. On account of these two reasons, inspite of a high demand, newsprint production has been completely overlooked in India by the private mill owners. However the Government of India took a decision in 1947 to establish a newsprint factory in public sector. The factory, known as National Newsprint and Paper Mills Ltd., Nepa Nagar, M.P. had been registered in 1947. It started production of newsprint from 1955 with an initial capacity of 30,000 tons which has been extended to 60,000 tons now. The factory initially operated at a very low level of output and could achieve the capacity production from 1963 onward. Beside this factory, some other paper mills were granted licences with easy terms to produce newsprint. The position of newsprint production upto 1964 was as given in Table 3.2.

3.2.3 Value Added:

In Table 3.10A gross value of output, material inputs, depreciation, net value added and total cost of production together with their indicies covering the

Table 3.2

Production of Newsprint in India 1951-1964

Year	Production of Newsprint	% Share of Domestic Supply of Newsprint in its Total Consumption
1951	0	0.0
1952	0	0.0
1953	0	0.0
1954	0	0.0
1955	3.0	3.8
1956	11.0	13.2
1957	15.0	19.2
1958	22.0	27.3
1959	21.0	21.9
1960	23.0	23.4
1961	26.0	20.9
1962	25.0	20.1
1963	30.0	23.8
1964	32.0	24.9

Source: U.N: Statistical Year books 1960, 1968.

period 1948-64, are given for the industry. Compared with the 1948 levels, we find that the gross value of output was 928% higher in 1964, total cost of production 1066%, gross value of materials and fuel etc. 1033%, depreciation 1690% and value added 675%. As the index series show, upto 1958 growth in the gross value of materials, fuel etc. and the total cost of production was slower than the growth in the gross value of output, but since 1959, both of them were superseeding it. A rise in the total cost of production relative to the groess value of output means a decline in the share of profit in the total output. Similarly, a rise in the value of the gross material inputs relative to the gross value of output means a decline in the share of the value added. Since January 1, 1960, there was a control on the prices of paper and paperboard in the country. This brought down the rate of growth in the revenue (i.e. gross value of output) of the industry. On the other hand input prices were free to vary. Consequently the percentage share of value added in the gross value of output, and the profit margin ((revenue)-(cost of production), overlooking the sales costs) of the industry declined sharply since the beginning of sixties (Ref: Table 3.10B). The profit margin fluctuated between 11 to 23% during the period 1948-59 but from 1960 onwards when the prices of paper were controlled, it came

down to 6 to 8%. Even in 1959 it declined inspite of the increase in the prices of paper and paperboard. From the point of view of profitability, 1951 to 1958, was a golden period in the history of the paper industry in India. The percentage share of value added in the gross value of output fluctuated between 35 to 42.5% during the period 1948-58 but came down to 27 - 28% since 1960. In 1959 it was 31.2%.

Growth in the depreciation cost was consistent with the growth of plant and machinery part of the fixed capital during the period 1948-64. The speed of growth in the net value added was more or less consistent with the growth of the gross value of output upto 1958 but from 1959 onwards it has been very slow or even negative for some years because of the control of paper prices and rising cost of production (Ref: Table 3.10A).

The distribution of the value added among primary inputs was very much uneven during the period 1948-64. As we see in Table 3.10B, there was a downward trend in the percent share of wages, salaries and benefits in the value-added upto 1958 but in 1959 and 1960 it went up and again had a downward trend since 1961. Although the number of persons employed in the industry and their average earnings were rising during the period 1948-64 but it was too slow in comparison with the growth in the fixed capital. A

rising trend in the share of capital (depreciation + imputed interest) and residual income (profit, etc.) because of the increasing amount of fixed capital, and rising prices of paper and paperboard, caused a downward trend in the share of wages, salaries etc., in the value added by the industry during the period 1948-64 except in 1959 and 1960. From 1960 onwards, because of the control of paper prices, the share of 'residual income' has declined which pushed up the share of wages, salaries and benefits to higher range, 49.3 to 46.5% as compared with 34 to 40% during the period 1956-59. The share of wages only, in the value added by the industry, behaved similarly during 1948-64 as the share of total wages, salaries and benefits (Ref: Col. 4 of Table 3.10B).

3.3 Trends in Average Productivity of Inputs and Technological Structure of the Industry:

So far we have discussed some major trends in the growth and structure of the aggregate inputs and output of the industry. In this section we present the historical trends in some productivity indices and technological structure of the industry covering the period 1948-1964.

From the data given in Tables 3.11(A) and 3.11(B), we find some interesting trends in the 'size'

and technological structure of the industry. Productivity (both in value and quantity terms) per factory was increasing upto 1959 except for the year 1953, 1954, but later on it declined. This implies that proportionate change in the total productivity of the industry was greater than the proportionate change in the number of factories upto 1959, but the order has been reversed since 1960 when the prices of paper and paperboard were controlled and at the same time number of the factories started increasing rapidly. Similarly, there has been a rising trend in the value of fixed capital per factory since 1948. As compared with its 1948 level of Rs. 15.34 lakhs, it has increased to Rs.65.43 lakhs in 1964 showing a net change of 326.5% in 16 years. The number of persons employed per factory declined from 582 in 1948 to 488 in 1953 but increased in the subsequent 6 years reaching the peak of 774 in 1959, after that there was again a decline in it during the period 1961-64. Similar trend, as in the average number of persons employed, was going on in the manhours worked per factory. The 1964 level of the manhours worked per factory was 26.5% below the 1948 level. In all these four variables i.e. productivity, fixed capital, number of persons employed and 'manhours' worked per factory, there were some shortrun cyclical fluctuations but their longrun trends were either increasing or decreasing. Out

of these four variables, we find fairly good consistency in the growth of the fixed capital per factory and the production per factory. The magnitudes of change in both of them were different but the trend was similar. It shows that increase in the fixed capital, rather than labour, was the main source of increase in the productivity of the factories in the industry.

The technological structure of an industry is represented in terms of ratios between inputs and output. These ratios are called "technical coefficients" or "Structural coefficients" in Leontief's terminology (Leontief, 1941). If the coefficients, expressed in quantity terms, do not vary, we call it stable technology otherwise it is dynamic or changing. The technical coefficients if expressed in value terms, are product of the coefficients in quantity terms and relative prices. On the basis of these 'value' coefficients we cannot say anything precisely regarding the technological changes unless the relative prices are known or constant. However, to see whether the technological structure of the paper industry was changing in India or not during the period 1948-64, we have calculated some ratios in value terms for simplicity and one in quantity terms. On the basis of these ratios we will analyze the main trends in the technological structure of the industry.

The coefficients we have calculated are: productivity per unit of fixed capital (output/capital ratio); productivity per manyear worked; productivity per person employed in the industry (output/labour ratio); capital-labour ratio and consumption of energy per 1000 manhours worked and per unit of output. (Ref: Table 3.11(B)). We have already defined 'productivity' as the gross value of output at current prices. Fixed capital is also taken in value terms (book value). Remaining variables are in numbers except energy which in terms of coal equivalents (Tonnes).

From the table we find that productivity per unit of fixed capital has declined during the period 1948-64. As compared with 1948 level (Rs. 0.61 per rupee investment on fixed capital), it was 40% less in 1964 (Rs.0.41). This indicates the faster growth of the capital input than the output of the industry. As we have seen earlier, there has been practically uniform change in the prices of capital goods and paper during the period 1948-64, so it was mainly the rapid increase in the quantity of fixed capital relative to the quantity of paper and paperboard produced, which caused a downward trend in the productivity per unit of capital. Productivity per 'man year' worked or per person employed had a rising trend during 1948-64, because of the rising capital per unit

of labour which was Rs. 8006 in 1948 but increased to Rs.51303 in 1964 showing 541% increase. Consumption of energy (coal equivalents) per 1000 manhours worked was rising since 1948. It was 7.75 tonnes per thousand manhours worked in 1948 which increased to 10.40 tonnes in 1964 (34% higher). On the other hand consumption of energy (coal equivalents) per tonne of output declined during the period 1948-64. It was 3.52 tonnes per tonne of output in 1948, which came down to 1.99 tonnes, 43.5% less than the 1948 level, in 1964. Thus, from the historical trends in the indicies like capital-output ratio (or its inverse i.e. output - capital ratio), capital-labour ratio and consumption of energy per unit of labour or output, we get overwhelming evidence in favour of the changing technological structure in the Indian paper industry during the period 1948-64. The pivotal factor that led a sequence of the changes in the technological structure of the industry during this period was, in fact, the rising capital intensity.

In this chapter we have gone through the historical trends in the input output structure of the Indian paper industry covering the period 1948-64. Nothing has been said regarding the formal relationships between output and inputs of the industry. In chapter 5, we will study this aspect of the industry through estimating a set of the production functions.

3.4 Summary of the Chapter and Conclusions:

In this chapter we have presented the historical trends that developed in the input-output structure of the Indian paper industry during the period 1948-1964. The main finding of the chapter can be summarised as follows:

1. During the period 1948-1964 the annual rate of growth of the capital in the industry was more than double of the rate of growth in its labour input. As a result of this, the capital-labour production was on rising trend during this period.

2. The annual growth in the total consumption of fuel and power has maintained its parity with the growth of 'plant and machinery' part of the fixed capital during the period 1948-1964. However, among the different sources of power, the relative position of coal was declining and that of fuel oil and electricity was rising in the industry during this period.

3. The raw materials consumption pattern of the industry has gone under some changes during the period 1948-1964. Because of the shortage of bamboo, there has been increasing consumption of auxiliary raw materials such as bagasse, waste paper, straw and rags etc. As a result of this, the percentage share of bamboo in the

total value of basic raw materials declined and that of rags etc. increased during this period. In the total value of materials consumed by the industry, its constituent parts, namely, basic raw materials, chemicals, packaging and consumable stores and inward transportation costs (with exception of this upto certain extent) were, however, having almost constant shares during the period under review.

4. The output structure of the industry was fairly stable during the period 1948-1964. Printing and writing papers together constituted about 65% share in it and remaining 35% share went to the industrial papers such as wrapping papers and paperboard.

5. The value added expressed in relative terms, was 35 to 42% of the gross output of the industry upto the year 1958 but there after it declined to 27 to 28% because of the partial control on prices of paper and paperboard.

6. The percentage share of capital in the value added (at current prices) by the industry has been fluctuating between 50 to 65% for most of the period under review. In 1948 it was, however, only 45%.

7. The profitability, judged on the basis of the percentage share of profit margin (i.e. total value of output - total cost of production, assuming zero sales

costs) in the gross value of output, was quite impressive (11 to 20%) upto the year 1959, but soon after, because of the control on paper prices, it declined sharply (6 to 7.5%).

8. The fixed capital per factory and value of gross output per factory which are taken as alternative measures of the average size of the factories, were on rising trend in the paper industry of India during the period 1948-64. At the same time the indicies showing 'manhours' worked per factory and 'number of persons employed' per factory were on declining trends in the industry.

9. The productivity (value of output) per unit of fixed capital (i.e. inverse of capital-output ratio) was declining in the paper industry of India during the period 1948-64 because of the faster growth of the fixed capital stock than the growth of the output in the industry. At the same time, the productivity (value of output) per person employed in the industry or per 'manyear' worked by workers only, was rising, mainly, because of the increasing capital intensity (capital - labour ratio) or what we call 'capital deeping' in the industry.

10. The following table shows a summary view of the growth in different categories of inputs and output of the industry during the period under review.

Table 3.3

Summary of Growth in Input-Output Structure of Indian Paper Industry (1948-64)

Item	Unit	1948	1964	% Growth during 1948-64 (1948=100)
1. Number of factories Registered		39 (CMI Units)	146 (ASI Units)	Not comparable
2. Total productive Capital	Rs Lakhs	911.0	12673.7	1291.0
(a) Working capital	"	314.4	2852.7	807.2
(b) Fixed capital of which	"	596.7	9822.0	1540.60
(1) Plant & Machinery	"	339.4	7454.1	2096.3
(2) Land & Building	"	257.2	2367.8	820.4
3. Total number of Persons employed	Number	22631	66315	193.0
(a) Workers	"	20127	55052	173.0
(b) Other than workers (i.e. Non-Workers)	"	2504	11263	349.7
(c) Manhours worked	(000)	50704	153179	202.1
(d) Total Salary, Wages Benefits,etc.)	Rs.Lakhs	222.2	1551.5	598.2
(e) Average Annual Wage per worker	Rs.	768.0	1677.6	118.5
(f) Average Annual Salary per non-worker.	Rs.	2407.1	4324.7	79.9

contd.

Table 3.3 contd.

Item	Unit	1948	1964	% Growth during 1948-64 (1948 = 100)
4. Total Fuel & Power etc. consumed (at current Price)	Rs.Lakhs	115.3	1123.2	874.3
Qty. of coal	000 Tons	356.0	1237.2	247
Qty. of Electricity	000 KWH	36829	534441	1351
Qty. of Fuel Oils	000 Gal	1046.1	16512.4	1478
5. Value (current) of				
(a) Basic Raw Materials	Rs.Lakhs	274.5	3373.1	1128.7
(b) Chemicals	"	167.9	1728.8	929.6
(c) Packaging & others	"	84.5	7591	798.2
(d) Total Materials at Factory	"	527.3	5963.5	1031.0
6. Output of				
(a) Printing & Writing Papers	000Tons	56.6	353.7	524.7
(b) Wrapping Papers	"	16.2	58.0	257.6
(c) 'Other Varieties'	"	2.58	23.33	802.8
(d) Board	"	34.3	168.9	393.3
(e) Newsprint	"	0	32.0	-
7(a) Gross Value of Output	Rs.Lakhs	1102.0	11327.6	927.9
(b) Gross Value of materials etc.	"	644.7	7305.9	1033.3
(c) Value Added (Net)	"	409.8	3174.3	674.7
8. Structure of the Industry:				
(a) Fixed capital per factory	Rs.Lakhs	15.34	65.43	326.5
(b) Number of Persons per factory	Number	582	415	-28.7

Contd...

Table 3.3 c ndt.

Item	Unit	1948	1964	% Growth during 1948-64 (1948=100)
(c) Manhours worked per factory	(ooo)	1303.8	957.9	-26.5
(d) Output per factory	(Rs.Lakh)	28.34	72.67	156.45
(e) Producticity per unit of fixed capital	Rs.	0.68	0.41	-39.87
(f) Productivity per person employed	Rs.	48.69	17523	259.9
(g) Fixed capital per worker	Rs	8006	51303	541.1
(h) Consumption of energy per 000, manyears worked	Tonnes of Coal	7.75	10.40	34.2

Source: Tables 3.4 to 3.11(B).

Table 3.4

Selected Capital Series for Indian Paper Industry
1948-1964

Value: Rs. Lakhs
Index: 1948=100

Year	TOTAL PRODUCTIVE CAPITAL		FIXED CAPITAL		WORKING CAPITAL	
	Value	Index	Value	Index	Value	Index
1	2	3	4	5	6	7
1948	911.0	100.0	596.7	100.0	314.4	100.0
1949	1104.9	121.3	659.6	110.5	445.4	141.7
1950	1584.4	173.9	1064.9	178.5	519.4	165.2
1951	1940.0	213.0	1180.5	197.8	759.6	241.6
1952	1995.3	219.0	1183.7	198.4	811.6	258.2
1953	2190.6	240.5	1360.2	228.0	830.4	264.2
1954	2109.6	231.6	1323.3	221.8	786.2	250.1
1955	2565.4	281.6	1536.1	257.5	1028.8	327.3
1956	3182.3	349.3	1976.4	331.2	1205.8	383.6
1957	4199.5	461.0	2872.4	481.4	1327.1	422.2
1958	4785.4	525.3	3293.7	552.0	1491.8	474.6
1959	5210.8	572.0	4008.1	671.7	1202.7	382.6
1960	6430.6	705.9	5204.2	872.2	1226.4	390.1
1961	6799.0	746.3	5063.2	848.6	1736.0	552.2
1962	9253.8	1015.8	6741.2	1129.8	2512.7	799.3
1963	10927.6	1199.5	8215.8	1377.0	2711.7	862.6
1964	12673.7	1391.1	9822.0	1646.0	2851.7	907.2
Cumulative Growth Rate	–	16.75%	–	17.91%	–	13.85%
Net Change Between 1948-64	–	1291%	–	1546%	–	807.2%

(Table 3.4 contd)

Year	TOTAL PRODUCTIVE CAPITAL		TOTAL FIXED CAPITAL AT 1952-53 Prices		PLANT MACHINES & TOOLS etc.	
	% shareof fixed cap.	% shareof workingCap	Value	Index	Value	Index
1	8	9	10	11	12	13
1948	65.5	34.5	710.1	100.0	339.4	100.0
1949	59.7	40.3	750.6	105.9	380.8	112.2
1950	67.2	32.8	1210.0	170.4	66622	196.3
1951	60.8	39.2	1142.0	160.9	779.4	229.4
1952	59.3	40.7	1184.0	166.7	768.7	226.5
1953	62.1	37.9	1356.0	190.9	905.8	266.9
1954	62.7	37.3	1356.0	190.9	885.4	260.9
1955	59.8	40.2	1613.0	227.1	1050.0	309.4
1956	62.1	37.9	1992.0	280.4	1399.8	412.4
1957	68.4	31.6	2777.0	391.0	1972.8	581.3
1958	68.8	31.2	3132.0	441.0	2396.3	706.0
1959	76.9	23.1	3644.0	513.5	2910.0	857.4
1960	80.9	19.1	4522.0	636.6	3380.6	996.1
1961	74.5	25.5	4258.0	599.6	3564.4	1050.2
1962	72.8	27.2	5468.0	769.8	5081.6	1497.2
1963	75.8	24.2	6440.0	906.7	5908.8	1740.9
1964	77.5	22.5	7811.0	1100.0	7454.1	2196.3
Cum. Growth Rate		–	–	15.2%	–	19.93%
Net change between 1948-64			–	1000%	–	2096.3%

Contd...

(Table 3.4 contd)

Year	LAND, BUILDING ETC. Value	Index	% Share of Plant, Machines etc. in Fixed Capital	% Share of Land, Building etc. in Fixed Capital
1	14	15	16	17
1948	257.2	100.0	56.9	43.1
1949	278.8	108.4	57.7	42.3
1950	398.7	155.0	62.6	37.4
1951	401.0	155.9	66.0	34.0
1952	415.0	161.3	64.9	35.1
1953	454.4	176.6	66.6	33.4
1954	437.9	170.2	66.9	33.1
1955	486.1	188.9	68.4	32.6
1956	576.6	224.1	70.8	29.2
1957	899.6	349.7	68.7	31.3
1958	896.4	348.4	72.8	27.2
1959	1098.0	426.8	72.6	27.4
1960	1908.5	741.8	65.0	35.0
1961	1498.5	582.5	70.4	29.6
1962	1660.6	645.5	75.4	24.6
1963	2307.0	896.8	71.9	28.1
1964	2367.8	920.4	75.9	24.1
Cum. Growth Rate	–	13.95%	–	–
Net change between 1948-64		820.4%	–	–

Contd...

(Table 3.4 contd.)

Year	PLANT, MACHINES & TOOLS AT 1952-53 PRICES		STOCK OF FINISHED PRODUCTS WITH INDUSTRY	
	Value	Index	Value	Index
1	18	19	20	21
1948	445.7	100.0	69.7	100.0
1949	478.5	107.4	128.8	184.7
1950	829.4	186.1	88.1	126.3
1951	842.4	189.0	90.4	129.6
1952	768.7	172.8	100.3	143.9
1953	925.8	207.7	115.3	165.3
1954	913.1	204.8	102.2	146.6
1955	1078.0	241.9	166.7	239.1
1956	1414.0	317.1	191.7	274.9
1957	1936.0	434.5	129.3	185.5
1958	2301.0	516.4	123.4	176.9
1959	2735.0	613.8	173.1	248.3
1960	3019.0	677.5	281.1	403.2
1961	3080.0	691.0	386.4	554.1
1962	4269.0	957.9	377.3	541.0
1963	4676.0	1049.0	470.6	674.8
1964	6232.0	1398.0	577.8	828.6
Cum. Growth Rate	-	16.8%	-	13.5%
Net change between 1948-64		1298%	-	728.6%

Table 3.5A

Employment in Paper Industry: Number of Workers, Nonworkers and Total Persons Employed in Indian Paper Inddstry 1948-64

Year	TOTAL NUMBER OF PERSONS EMPLOYED		WORKERS	
	Number	Index 1948=100	Number	Index 1948=100
1	2	3	4	5
1948	22631	100.0	20127	100.0
1949	22800	100.7	20542	101.9
1950	23905	105.6	21480	106.5
1951	24539	108.4	21763	107.9
1952	23630	104.4	20764	103.0
1953	24436	108.0	21509	106.7
1954	26395	116.6	22731	112.8
1955	29655	131.0	25763	127.8
1956	32571	143.7	27760	137.7
1957	37968	167.8	32110	159.3
1958	44826	198.1	37944	188.2
1959	45375	200.5	38464	190.8
1960	53189	235.0	45400	225.2
1961	49472	218.6	43008	213.3
1962	56757	250.8	48653	241.3
1963	64806	286.4	54502	270.3
1964	66315	293.0	55052	273.1
Cumulative Growth Rate (Per Year)	-	6.5%	-	6.1%
% Growth during 1948-64	-	193.0%	-	173%

(Table 3.5A contd.)

Year	NON-WORKERS Number	NON-WORKERS Index 1948=100	MANHOURS WORKED Number (000)	MANHOURS WORKED Index 1948=100	% Share of Workers in Total Employment
1	6	7	8	9	10
1948	2504	100.0	50704	100.0	89.1
1949	2258	90.2	54501	107.5	90.1
1950	2425	96.8	50703	100.0	89.9
1951	2776	110.8	53450	105.4	88.7
1952	2874	114.7	54508	107.5	87.7
1953	2927	116.9	48996	96.6	88.0
1954	3664	146.3	49877	98.4	86.1
1955	3892	155.4	60962	120.2	86.9
1956	4761	190.1	65984	130.1	85.4
1957	5858	233.9	74213	146.4	84.6
1958	6882	274.8	87861	173.3	84.6
1959	6911	275.9	98819	194.9	84.8
1960	7789	311.0	117917	232.5	85.4
1961	6464	258.1	103464	204.1	86.9
1962	8104	323.6	119955	236.6	85.7
1963	10304	411.5	143564	283.1	84.1
1964	11263	442.7	153179	302.1	83.0
Cumulative Growth Rate (Per Year)	-	9.2%	-	6.7%	-
% Growth 1948-64	-	349.7%	-	202.1%	-

Table 3.5B

Employment in Paper Industry: Wages, Salaries & Benefits etc.

Year	TOTAL WAGES & BENEFITS TO WORKERS		TOTAL SALARY OF NON-WORKERS		TOTAL SALARIES WAGES AND BENEFITS		Share of workers in total salary and wages etc.
	Rs. Lakhs	Index 1948=100	Rs. Lakhs	Index 1948=100	Rs. Lakhs	Index 1948=100	
1	2	3	4	5	6	7	8
1948	154.8	100.0	60.3	100.0	222.2	100.0	69.7
1949	170.4	110.0	57.6	95.6	234.8	105.6	72.6
1950	193.7	125.1	58.3	96.8	263.6	118.6	73.5
1951	227.8	147.1	80.4	133.4	322.6	145.2	70.6
1952	229.6	148.3	91.7	152.1	331.1	149.0	69.3
1953	217.6	140.5	90.9	150.7	321.8	144.8	67.6
1954	221.3	142.9	102.1	169.4	337.3	151.8	65.6
1955	263.7	170.3	120.3	199.5	407.4	183.3	64.7
1956	299.4	193.4	143.1	237.4	473.3	213.0	63.3
1957	350.7	232.9	171.0	283.7	563.0	253.3	64.1
1958	449.9	290.6	205.6	341.1	659.0	312.7	64.7
1959	504.5	325.8	248.7	412.6	817.6	367.9	61.7
1960	607.5	392.4	279.4	463.5	956.7	430.5	63.5
1961	628.9	406.1	249.4	413.6	956.5	430.4	65.7
1962	725.0	468.2	311.4	516.6	1126.4	506.9	64.4
1963	868.7	561.1	421.5	699.1	1410.4	634.6	61.6
1964	923.5	596.5	487.1	808.0	1551.5	698.2	59.5
Cummulative Growth Rate (Per Year)		11.1%	-	13.1%	-	12.1%	-
% Growth 1948-64		496.5%	-	708%	-	598.2%	

(Table 3.5B contd.)

Year	Average Earning Per Person per Year(Rs)*	Average Wage Per Worker per Year (Rs.)*	Average Wage per Manhour Worked (Rs.)	Average Salary per Nonworker Per Year (Rs.)
1	9	10	11	12
1948	982.0	768.0	0.30	2407.1
1949	1029.6(1053.2)	829.3(846.1)	0.30	2551.4
1950	1102.8(1124.8)	901.9(919.8)	0.40	2405.9
1951	1314.6(1289.3)	1046.7(1027.0)	0.40	2896.9
1952	1400.8(1400.8)	1105.6(1105.6)	0.40	3190.2
1953	1316.7(1279.3)	1011.6(982.2)	0.40	3104.5
1954	1277.8(1290.5)	973.5(962.9)	0.40	2787.5
1955	1373.8(1475.0)	1023.4(1049.0)	0.40	3090.1
1956	1455.4(1427.4)	1078.6(1058.0)	0.50	3006.1
1957	1482.9(1376.3)	1123.2(1042.0)	0.50	2920.0
1958	1550.5(1377.6)	1185.8(1054.0)	0.50	2988.0
1959	1801.8(1534.1)	1311.7(1116.0)	0.50	3598.7
1960	1798.6(1494.0)	1338.2(1111.0)	0.50	3587.2
1961	1933.3(1580.1)	1462.2(1195.0)	0.60	3857.6
1962	1984.7(1572.9)	1490.1(1181.0)	0.60	3843.3
1963	2176.3(1649.2)	1594.0(1208.0)	0.60	4090.2
1964	2339.7(1570.0)	1677.6(1126.0)	0.60	4324.7

*The figs. in brackets are deflated values. All India Consumers' Price Index (1952-53=100) has been used as deflater to get these figs.

Table 3.6 A

Percentage Distribution of Total Expenditure on 'Fuel, Power & Lubricants by Sources in the Paper Industry in India

Year	% Share of Expenditure on				
	Coal	Fuel Oils	Lubricants	Electricity	Others*
1948	72.10	4.68	3.47	13.52	6.23
1949	71.41	4.49	3.50	13.62	6.98
1950	67.04	5.15	3.51	16.01	8.29
1951	75.30	3.11	3.35	17.00	1.24
1952	75.24	4.69	3.68	15.02	1.37
1953	73.22	3.56	3.72	18.27	1.23
1954	65.88	4.66	3.55	23.54	2.37
1955	65.58	4.63	3.26	23.75	2.78
1956	68.82	4.11	2.90	21.38	2.79
1957	64.25	3.97	3.46	25.19	3.13
1958	57.99	4.41	2.48	33.14	1.98
1959	57.05	5.59	1.80	34.97	0.59
1960	57.46	5.78	2.50	33.38	0.88
1961	58.48	6.30	2.39	31.81	1.02
1962	54.13	6.10	2.15	35.51	2.11
1963	50.87	8.85	1.69	34.45	4.14
1964	47.88	10.92	2.02	36.56	2.62

*'Others' includes coke, charcoal, coalgas, water, and wood etc.

Source: CMI & ASI Reports.

Table 3.6B

Fuels, Power & Lubricants Consumed in Indian Paper Industry
Value & Quantity Series: 1948-64

Year	Total Fuel, Power & Lubricants at current Price Rs. Lakhs	Total Fuel Power & Lubricants at 1952-53 Prices	Qty.of Coal 000 Tons	Value of Coal Rs. Lakhs	Qty. of Fuel Oils 000 Gallons	Value of Fuel oils Rs. Lakhs
1	2	3	4	5	6	7
1948	115.3	123.0	356.0	83.11	1046.1	5.39
1949	119.9	132.6	363.6	85.64	1050.6	5.85
1950	133.6	137.8	377.2	89.55	1191.3	6.88
1951	162.3	167.9	512.1	122.18	863.8	5.04
1952	176.5	176.5	528.6	132.80	827.6	8.28
1953	172.9	169.2	504.1	126.58	625.6	6.15
1954	169.9	166.5	442.0	111.92	956.8	7.92
1955	222.5	216.3	581.6	145.92	1333.4	10.30
1956	285.2	266.0	729.1	196.30	1372.5	11.72
1957	392.4	327.7	827.7	252.11	1912.9	15.59
1958	519.9	397.9	941.7	301.49	2867.4	22.93
1959	556.0	419.7	977.9	322.9	3841.9*	37.32*
1960	679.9	480.7	1095.2	390.7	4067.0	39.29
1961	719.9	511.8	1131.3	421.0	4777.0	45.36
1962	829.4	541.9	1138.1	449.0	5750.3	50.58
1963	1088.2	667.50	1307.2	553.6	14224.2	96.33
1964	1123.2	670.1	1237.2	537.8	16512.4	122.69

*Estimated

Source: CMI & ASI Reports

Contd...

(Table 3.6B contd.)

Year	Qty. of Lubricants 000 Gallons	Value of Lubricants Rs.Lakhs	Qty. of Electricity Thousand KWH	Value of Electricity Rs. Lakhs
1	8	9	10	11
1948	103.7	4.00	36829.0	15.58
1949	100.8	4.19	52433.6	16.34
1950	111.6	4.69	45423.8	21.38
1951	118.5	5.44	60149.6	27.59
1952	131.1	6.49	60914.5	26.51
1953	129.8	6.44	64675.1	31.59
1954	126.8	6.03	83189.9	39.99
1955	151.6	7.25	110838.6	52.85
1956	174.8	8.26	127598.0	60.98
1957	261.1	13.57	187909.0	98.83
1958	238.3	12.89	280442.9	172.29
1959	290.1*	15.23*	321453.2	197.94
1960	353.8	17.00	346033.0	226.97
1961	323.1	17.18	350191.3	228.97
1962	319.3	17.85	427191.6	294.56
1963	318.9	18.42	573454.5	374.85
1964	388.1	22.72	534440.7	410.68

*Estimated

Table 3.6C

Fuel, Power and Lubricants Consumed Indian Paper Industry 1948-64 (Index Series 1948=100)

Year	Total Fuel, Power & Lubricants at current Prices	Total Fuel Power & Lubricants at 1952-53 Prices.	Qty. of Coal	Value of Coal	Qty. of Fuel Oils	Value of Fuel Oils
1	2	3	4	5	6	7
1948	100.0	100.0	100.0	100.0	100.0	100.0
1949	104.0	107.9	102.2	103.1	100.5	108.5
1950	115.9	112.0	106.0	107.8	113.9	127.6
1951	140.8	136.5	143.9	147.0	82.6	93.6
1952	153.1	143.2	148.5	159.8	79.1	153.6
1953	150.0	137.6	141.6	152.3	59.8	114.2
1954	147.4	135.4	124.2	134.7	91.5	146.9
1955.	193.0	175.9	163.4	175.6	127.5	191.0
1956	247.4	216.3	204.8	236.2	131.2	217.5
1957	340.4	266.5	232.5	303.3	182.9	289.3
1958	451.0	323.5	264.6	362.8	274.1	425.5
1959	490.97	341.28	274.70	388.50	367.25	692.50
1960	589.80	390.86	307.68	470.09	388.76	729.10
1961	624.49	416.18	317.97	506.56	456.63	841.73
1962	719.52	440.63	319.71	540.25	549.67	938.44
1963	943.94	542.78	367.22	666.05	1359.68	1787.34
1964	974.34	544.91	347.54	647.05	1578.40	2276.54
Cumulative Growth Rate Per Year						
	144.33	10.49	7.60	11.61%	17.62%	20.18%
% Growth during 1948-64						
	874.3%	445%	247%	547%	1478%	2176.5%

(Table 3.6C contd.)

Year	Qty. of Lubricants	Value of Lubricants	Qty. of Electricity	Value of Electricity
1	8	9	10	11
1948	100.00	100.00	100.00	100.00
1949.	97.2	104.9	142.4	104.9
1950	107.6	117.4	123.3	137.2
1951	114.3	136.0	163.3	177.0
1952	126.4	162.3	165.4	170.1
1953	125.1	161.1	175.6	202.7
1954	122.3	150.8	225.9	256.6
1955	146.2	181.3	301.0	339.2
1956	168.5	206.7	346.7	391.3
1957	251.7	339.5	510.2	634.2
1958	229.8	322.7	761.5	1105.7
1959	280.0	380.75	872.82	1270.24
1960	341.11	425.55	939.56	1456.49
1961	311.48	430.12	950.85	1469.34
1962	307.89	446.80	1159.92	1890.22
1963	307.50	461.12	1394.15	2405.47
1964	374.16	568.75	1451.13	2635.38
Cumulative Growth Rate Per year				
	8.07%	10.77%	17.04%	21.22%
% Growth during 1948-64				
	274%	468.8%	1351.1%	2535.4%

Table 3.6D

Price Series for Fuel, Power & Lubricants 1948-64

Year	Price of Coal Rs. Per Ton	Price of Coal Index 1948=100	Price of Fuel Oils Rs. Per Gallon	Price of Fuel Oils Index 1948=100
1948	23.35	100.00	0.52	100.00
1949	23.55	100.88	0.52	100.00
1950	23.74	101.68	0.58	112.04
1951	23.86	102.18	0.58	113.34
1952	25.12	107.61	1.00	194.14
1953	25.11	107.54	0.98	190.96
1954	25.32	108.50	0.83	160.60
1955	25.09	107.47	0.77	149.87
1956	26.93	115.32	0.85	165.80
1957	30.46	130.46	0.82	158.22
1958	32.01	137.12	0.80	155.24
1959	33.02	141.43	0.93	188.57
1960	35.67	152.79	0.97	187.54
1961	37.22	159.40	0.95	184.33
1962	39.45	168.98	0.88	170.73
1963	42.35	181.37	0.68	131.45
1964	43.47	186.18	0.74	144.23

contd...

(Table 3.6D contd.)

Year	Price of Lubricants Rs. Per Gallon	Price of Lubricants Index 1948=100	Price of Electricity Rs KWH	Price of Electricity Index 1948=100	Aggregate Price Index for Fuel, Power & Lubricants
1	6	7	8	9	10
1948	3.85	100.00	0.04	100.00	100.00
1949	4.16	107.95	0.03	73.65	96.46
1950	4.20	109.11	0.05	111.24	103.43
1951	4.59	119.05	0.05	108.39	103.09
1952	4.95	128.41	0.04	102.87	106.90
1953	4.96	128.77	0.05	115.42	108.90
1954	4.75	123.34	0.05	113.60	108.88
1955	4.78	124.06	0.05	112.70	109.76
1956	4.73	122.64	0.05	112.94	114.35
1957	5.20	134.88	0.05	124.30	127.71
1958	5.41	140.44	0.06	145.20	139.40
1959	5.37	139.29	0.06	145.53	143.80
1960	4.81	124.76	0.07	155.02	150.90
1961	5.32	138.09	0.08	154.53	150.05
1962	5.59	145.12	0.07	162.96	163.30
1963	5.78	149.95	0.07	172.54	173.80
1964	5.86	152.01	0.08	181.61	178.80

Source: CMI:ASI SERIES REPORTS

Table 3.7A

Consumption of Basic Raw Materials by Indian Paper Industry (Qty. and Value Series)

Year	PULP		GRASS		BAMBOO	
	Qty. 000 Tons	Value Rs. Lakhs	Qty. 000 Tons	Value Rs. Lakhs	Qty. 000 Tons	Value Rs. Lakhs
1	2	3	4	5	6	7
1948	3.1	24.4	51.4	48.0	117.1	97.0
1949	10.9	72.6	53.8	55.9	141.5	122.7
1950	7.8	38.0	54.8	55.6	159.4	132.9
1951	2.4	16.0	64.3	72.5	205.4	173.9
1952	20.2	150.5	58.6	64.3	210.4	186.6
1953	19.0	136.7	60.0	64.6	253.8	160.0
1954	18.1	135.5	57.8	60.2	209.9	156.3
1955	21.4	162.0	70.2	70.6	279.2	198.8
1956	20.8	162.5	99.8	94.4	296.8	212.5
1957	40.3	195.8	75.2	78.2	410.5	298.1
1958	54.4	433.0	88.3	92.4	474.2	370.7
1959	36.4	292.2	88.9	88.9	516.9	461.7
1960	44.5	352.4	88.5	85.9	689.4	548.8
1961	26.7	219.9	87.9	89.9	754.8	832.8
1962	40.2	323.2	102.1	113.7	769.4	889.2
1963	47.9	374.4	114.2	119.3	923.5	767.3
1964	46.1	394.2	88.2	103.8	999.7	873.1

contd...

Table 3.7A contd.)

ear	WASTE PAPER		BAGASSE	
	Qty. 000 Tons	Value Rs.Lakhs	Qty. 000 Tons	Value Rs.Lakhs
1	8	9	10	11
948	25.1	55.10	9.2	1.7
949	20.2	46.2	7.1	1.7
950	20.2	48.6	4.4	1.5
951	25.6	64.1	15.6	5.9
952	19.5	49.7	15.0	5.6
953	26.5	62.5	14.0	4.4
954	32.7	81.0	15.0	4.5
955	45.3	114.0	18.0	4.6
956	51.0	144.2	34.4	5.8
957	57.3	170.6	26.5	7.2
958	74.0	262.3	25.3	7.6
1959	73.5	266.6	47.4	17.8
1960	74.9	288.4	49.8	20.2
1961	92.5	319.3	126.4	61.7
1962	89.0	353.3	81.2	41.0
1963	98.3	387.7	81.8	51.8
1964	108.2	418.3	78.2	47.9

Source: CMI : ASI Reports

Table 3.7B

Consumption of Basic Raw Materials by Indian Paper Industry
(Index Series)

	PULP		GRASS		BAMBOO	
Year	Qty.	Value	Qty.	Value	Qty.	Value
1	2	3	4	5	6	7
1948	100.00	100.00	100.00	100.00	100.00	100.00
1949	351.16	297.62	104.62	116.53	120.78	126.55
1950	250.22	156.08	106.53	116.01	136.07	137.07
1951	75.62	65.74	125.06	151.17	175.35	179.35
1952	649.83	616.95	113.94	133.98	179.98	192.40
1953	611.37	560.41	116.64	134.78	216.69	165.04
1954	583.21	555.49	112.42	125.49	179.19	161.18
1955	688.35	664.06	136.59	147.18	238.42	205.00
1956	669.15	666.31	194.08	196.94	253.45	219.17
1957	1295.76	802.97	146.25	163.17	350.48	307.39
1958	1750.69	1775.59	171.76	192.72	404.91	382.24
1959	1172.38	1198.19	172.88	185.31	476.06	475.75
1960	1432.11	1445.01	172.26	179.20	588.58	565.94
1961	857.88	901.47	170.93	187.29	644.45	858.78
1962	1291.83	1325.19	198.68	237.68	656.92	916.97
1963	1539.92	1535.04	222.09	248.82	788.53	791.29
1964	1484.66	1616.27	171.56	216.56	853.59	900.31

Cumulative Growth Rates Per year

17.20%	17.78%	3.23%	4.65%	13.44%	13.80%

% Growth during 1948-64

1384.7%	1516.27%	071.56%	116.56%	753.59%	800.3%

(Table 3.7B contd.)

Year	WASTE PAPER Qty.	WASTE PAPER Value	BAGASSE Qty.	BAGASSE Value
1	8	9	10	11
1948	100.0	100.00	100.00	100.00
1949	80.78	83.92	77.00	97.37
1950	80.61	88.18	47.39	86.55
1951	102.15	116.38	169.50	347.79
1952	77.65	90.22	163.24	329.04
1953	105.72	113.36	152.65	258.63
1954	130.56	146.53	162.96	262.88
1955	180.62	206.79	197.52	273.53
1956	203.06	261.72	374.30	340.76
1957	228.52	309.53	288.47	423.49
1958	295.27	475.89	275.70	449.37
1959	293.11	483.74	515.89	1046.29
1960	298.94	523.37	540.84	1189.87
1961	368.89	579.40	1376.18	3634.77
1962	355.03	641.04	883.76	2416.33
1963	392.37	703.56	889.94	3047.27
1964	431.55	759.07	851.22	2821.21
Cumulative Growth Rates Per year				
	8.98%	12.66%	13.42%	21.71%
% Growth during 1948-64				
	331.55%	659.07%	751.22%	2721.2%

Table 3.7C

Percentage Distribution of Total Value of Basic Materials by Sources

Year	Pulp	Grass	Bamboo	Waste Paper	Bagasse	Rags & Other
1948	8.9	17.5	35.3	20.1	0.6	17.6
1949	21.0	16.2	35.5	13.4	0.5	13.4
1950	11.8	17.2	41.1	15.0	0.5	14.4
1951	3.8	17.4	41.7	15.4	1.4	20.3
1952	27.6	11.8	34.2	9.1	1.0	16.3
1953	26.6	12.6	31.1	12.1	0.9	16.7
1954	25.0	11.1	28.9	14.9	0.8	19.3
1955	24.0	10.4	29.4	16.9	0.7	19.6
1956	21.8	12.7	28.6	19.4	0.8	16.7
1957	21.6	8.6	32.9	18.8	0.8	17.3
1958	30.8	6.6	26.3	18.6	0.5	17.2
1959	15.4	4.7	39.7	14.1	0.9	25.2
1960	16.6	4.0	25.8	13.6	1.0	39.0
1961	9.1	3.7	34.4	13.2	2.5	37.1
1962	11.7	4.1	32.3	12.8	1.5	37.6
1963	11.9	3.8	24.4	12.3	1.6	46.0
1964	11.7	3.1	25.9	12.4	1.4	45.5

Source: Derived from Table 3.7A.

Table 3.7D

Prices of Selected Basic Raw Materials of Paper Industry 1948-64

Year	PRICE OF PULP		PRICE OF GRASS		PRICE OF BAMBOO	
	Rs. Ton	Index 1952=100	Rs. Ton	Index 1952=100	Rs. Ton.	Index 1952=100
1	2	3	4	5	6	7
1948	784.8	105.3	93.3	85.0	82.8	93.4
1949	665.7	89.3	103.9	94.7	86.8	97.8
1950	489.5	65.7	101.6	92.6	83.4	94.0
1951	682.3	91.6	112.8	102.8	84.7	95.5
1952	745.1	100.0	109.7	100.0	88.8	100.0
1953	719.3	96.6	107.8	98.3	63.1	71.1
1954	747.5	100.3	104.1	94.9	74.5	84.0
1955	757.1	101.6	100.5	91.6	71.2	80.3
1956	781.4	104.9	94.7	86.3	71.6	80.7
1957	786.0	105.3	104.1	94.9	72.6	81.9
1958	795.9	106.8	104.7	95.4	78.2	88.1
1959	802.0	107.6	100.0	91.2	80.7	91.0
1960	791.8	106.3	97.1	88.5	79.6	89.8
1961	824.6	110.7	102.2	93.2	110.3	124.4
1962	805.0	108.1	111.4	101.5	115.6	130.3
1963	782.3	105.0	104.5	95.3	83.1	93.7
1964	854.3	114.7	117.8	107.3	87.3	98.5

contd ...

(Table 3.7D contd.)

Year	PRICE OF WASTE PAPER		PRICE OF BAGESSE	
	Rs. Ton.	Index 1952=100	Rs. Ton.	Index 1952=100
1948	219.9	86.1	18.5	49.6
1949	228.4	89.4	23.4	62.7
1950	240.6	94.2	33.8	90.6
1951	250.5	98.1	37.9	101.8
1952	255.5	100.0	37.3	100.0
1953	235.8	92.3	31.3	84.1
1954	248.8	96.6	29.8	80.0
1955	251.7	98.5	25.6	68.7
1956	283.4	110.9	26.8	72.0
1957	297.8	116.6	27.1	72.8
1958	354.4	138.7	30.1	80.9
1959	362.9	142.0	37.5	100.6
1960	385.0	150.7	40.7	109.1
1961	345.4	135.2	48.8	131.0
1962	397.0	155.4	50.6	135.6
1963	394.3	154.3	63.3	169.9
1964	386.8	151.4	61.3	164.4

Source: Derived from Table 3.7A

Table 3.8A

Materials Consumed in Indian Paper Industry. Aggregate Value Series 1948-1964

Rs. Lakhs

Year	Value at Factory of Total Materials, Transport Cost & Commission etc.(3+4)	Value of Material only at current Prices (9+11)	Inward Transport Cost & Commission To Purchasing Agent	Basic Materials: Value at current Prices	Basic Materials: Value at 1952 Prices
1	2	3	4	5	6
1948	527.3	526.9	0.38	274.5	332.1
1949	658.3	657.9	0.33	345.5	367.2
1950	643.2	642.0	1.15	323.4	390.5
1951	913.1	908.4	4.68	417.5	523.1
1952	1068.2	1062.7	5.44	544.9	544.9
1953	985.4	982.8	2.05	514.8	612.6
1954	1040.9	1038.5	2.33	541.0	579.4
1955	1233.9	1232.1	1.82	686.8	729.2
1956	1412.1	1406.0	6.10	744.4	822.6
1957	1715.8	1703.3	12.49	906.0	1008.3
1958	2484.9	2472.4	12.52	1406.8	1225.3
1959	3343.0	3312.2	30.79	1895.7	1658.8
1960	3697.5	3648.9	48.60	2124.5	1822.8
1961	4091.5	4023.1	68.31	2423.7	2157.1
1962	4694.6	4646.1	48.53	2751.6	2121.4
1963	5621.1	5539.3	70.14	3141.0	2430.0
1964	5963.5	5861.0	102.56	3373.1	2577.1

(Table 3.8A contd.)

Year	CHEMICALS Value at current prices	CHEMICALS Value at 1952 prices	TOTAL BASIC & CHEMICALS Value at current prices	TOTAL BASIC & CHEMICALS Value at 1952 Prices	Packaging & consumable Materials at current prices
1948	167.9	238.4	442.4	570.5	84.5
1949	213.5	271.3	558.9	638.6	99.0
1950	216.3	242.9	539.7	634.1	101.2
1951	330.8	330.8	748.3	855.1	160.1
1952	339.3	339.3	884.2	884.2	178.6
1953	289.3	339.1	804.1	951.7	186.7
1954	313.7	316.8	854.7	896.2	183.8
1955	348.7	418.6	1024.5	1147.6	207.6
1956	425.8	459.8	1170.2	1282.4	235.8
1957	526.7	521.5	1432.7	1529.8	270.6
1958	715.5	674.0	2100.0	1899.3	350.0
1959	1001.2	840.0	2896.9	2498.8	296.2
1960	1082.3	863.7	3206.7	2686.5	442.1
1961	1033.0	840.9	3456.7	2998.0	566.3
1962	1251.1	1038.5	3996.9	3273.9	643.4
1963	1728.6	1436.5	4869.6	3866.4	669.7
1964	1728.8	1394.3	5101.9	3971.0	759.1

Source: CMI: ASI Reports

Table 3.8B

Materials Consumed in Indian Paper Industry, 1948-64
(Index of Value: 1948=100)

Year	Value at factory of Materials Trans. Costs, Commission etc. Total	Value of Materials only	Inward Transport cost and commission etc.	Value of Basic Materials At Current Prices	At Constant Prices
1	2	3	4	5	6
1948	100.0	100.0	100.0	100.0	100.0
1949	124.8	124.9	86.8	125.8	110.6
1950	122.0	121.8	298.2	117.8	117.6
1951	173.1	172.4	1219.2	152.1	157.5
1952	202.6	201.7	1416.9	198.5	164.1
1953	186.9	186.5	534.2	187.5	184.5
1954	197.4	197.1	605.9	197.1	174.5
1955	234.0	233.8	474.4	250.2	219.6
1956	267.8	266.8	1585.4	271.2	247.7
1957	325.4	323.2	3247.8	330.0	303.7
1958	471.2	469.2	3257.1	512.4	369.0
1959	633.9	628.6	8004.7	690.5	499.6
1960	701.2	692.4	12800.0	773.8	549.0
1961	775.9	763.5	18000.0	882.8	649.6
1962	890.2	881.7	12763.0	1002.3	638.9
1963	1066.0	105122	18458.0	1144.1	731.8
1964	1130.9	1112.2	26989.8	1228.7	776.1
Cumulative Growth Rates (Per Year)					
	15.34%	15.22%	38.90%	15.90%	12.81%
% Growth over 1948 level					
	1030.9%	1012.2%	26889.8%	1128.7%	676.1%

(Table 3.8B contd.)

Year	Value of Chemicals at current price	Value of Chemicals at constant price	Total Value of Basic & Chemicals at current Price	Total Value of Basic & Chemicals at constant Price	Packaging & other Consumable materials at current Prices
1	7	8	9	10	11
1948	100.0	100.0	100.0	100.0	100.0
1949	127.1	113.8	126.8	111.9	117.1
1950	128.8	101.9	122.0	111.1	119.8
1951	197.0	138.7	169.1	149.9	189.4
1952	202.1	142.3	199.8	155.0	211.3
1953	172.3	142.2	181.7	166.8	220.9
1954	186.8	132.9	193.2	157.1	217.5
1955	207.7	175.5	231.6	201.2	245.7
1956	253.6	192.9	264.5	224.8	279.0
1957	313.7	218.7	323.8	268.2	320.2
1958	426.2	282.7	474.6	332.9	414.2
1959	596.3	352.3	654.8	438.0	350.5
1960	644.6	362.3	724.8	470.0	523.1
1961	615.3	352.7	781.3	525.5	670.1
1962	745.1	435.6	903.4	573.9	761.3
1963	1029.5	602.6	1100.6	677.8	792.4
1964	1029.6	584.8	1153.1	698.2	898.2
Cumulative Growth Rate (Per Year)					
	14.70%	10.95%	15.47%	12.09%	13.78%
% Growth over 1948 level					
	929.6%	484.8%	1053.1%	598.2%	798.2%

Table 3.8

Structure of Total Material Cost & Some Price Indicies

Year	Total Value at Factory of Materials Consumed: Inbound Transport Costs.etc. (%)	Basic Mater-ials (%)	Chemi-cals (%)	Pack-aging Mater-ials (%)	Price Index for Basic Mater-ials 1952=100	Price Index for Chemi-cals 1952=100	Price Index for Basic & Chemicals 1952=100
1948	0.07	52.06	31.84	16.03	82.68	70.42	77.56
1949	0.05	52.48	32.43	15.04	94.07	78.68	87.53
1950	0.18	50.28	33.63	15.74	82.82	89.05	85.12
1951	0.51	45.73	36.23	17.53	79.81	100.00	87.51
1952	0.51	51.01	31.76	16.72	100.00	100.00	100.00
1953	0.21	52.24	29.36	18.94	84.03	85.32	84.49
1954	0.22	51.98	30.14	17.66	93.37	99.01	95.36
1955	0.15	55.66	28.26	16.83	94.19	83.33	89.27
1956	0.43	52.72	30.15	16.70	90.50	92.59	91.25
1957	0.73	52.80	30.70	15.77	89.85	101.01	93.65
1958	0.50	56.61	28.80	14.09	114.81	106.16	110.56
1959	0.90	56.71	29.95	13.44	114.29	119.18	115.93
1960	1.31	57.46	29.27	11.96	116.55	125.31	119.37
1961	1.67	59.24	25.25	13.84	112.36	122.85	115.30
1962	1.03	58.61	26.65	13.71	129.70	120.48	122.08
1963	1.25	55.88	30.75	11.91	129.26	120.34	125.95
1964	1.72	56.56	28.99	12.73	130.89	123.99	128.47

Source: Derived from Tables 3.8A & 3.7A.

Table 3.9 A

Percentage Distribution of Total Quantity of Paper & Paperboard by Types of Paper

Year	Printing & Writing Papers %	Wrapping Paper %	Other varieties %	Board %
1	2	3	4	5
1948	51.6	14.8	2.4	31.3
1949	56.7	8.8	3.4	31.1
1950	55.2	11.2	2.3	31.2
1951	50.4	15.7	3.1	30.8
1952	56.0	11.2	3.5	29.3
1953	54.1	10.5	6.2	29.3
1954	52.1	10.5	7.5	29.8
1955	50.5	10.0	7.6	32.0
1956	52.3	11.2	5.6	30.9
1957	46.6	11.2	4.7	32.5
1958	47.3	10.2	8.8	33.7
1959	48.5	13.4	7.2	30.9
1960	52.5	10.5	6.0	31.1
1961	53.1	11.0	3.7	32.2
1962	53.9	11.0	4.5	30.6
1963	58.3	9.7	4.4	27.5
1964	58.6	9.6	3.9	28.0

contd...

(Table 3.9 A contd.)

Percentage Distribution of the Value of Total Paper & Paperboard by Types of paper

1	2	3	4	5
1948	59.7	13.1	3.6	23.6
1949	65.1	8.0	4.2	22.7
1950	62.8	11.9	3.6	21.6
1951	52.9	17.1	5.4	24.6
1952	59.8	11.5	6.8	21.9
1953	61.8	10.3	10.8	17.1
1954	57.8	10.3	11.3	19.4
1955	56.3	9.8	12.4	21.5
1956	57.3	11.0	9.8	21.9
1957	51.9	11.7	12.7	23.7
1958	52.8	13.5	9.1	24.6
1959	55.7	11.4	11.6	21.3
1960	57.3	7.6	11.8	23.3
1961	58.6	10.2	7.7	23.5
1962	59.1	10.0	9.7	21.3
1963	64.1	8.7	7.3	19.9
1964	65.1	8.9	5.5	20.5

Source: CMI & ASI Reports.

Table 3.9B

Production of Paper & Paperboard (Excluding Newsprint)
Index Series of Qty. & Value

Year	PRINTING & WRITING		WRAPPING PAPER		OTHER VARIETIES	
	Qty.	Value	Qty.	Value	Qty.	Value
1948	100.0	100.0	100.0	100.0	100.0	100.0
1949	117.9	130.8	63.8	73.5	153.2	138.8
1950	119.8	136.8	84.6	118.0	111.3	131.2
1951	133.3	156.0	144.9	230.4	176.9	266.5
1952	167.4	195.2	116.5	170.6	230.4	365.9
1953	158.4	195.1	107.8	148.4	397.5	566.9
1954	160.7	192.2	113.5	155.4	507.9	621.0
1955	200.6	241.6	139.1	192.1	658.0	884.5
1956	228.4	274.0	169.9	240.5	538.1	775.8
1957	250.1	303.5	209.2	310.6	1136.2	1227.4
1958	288.3	410.3	217.3	323.8	1182.6	1743.6
1959	340.8	473.0	328.7	443.1	1114.4	1633.0
1960	386.7	462.1	268.9	279.8	970.3	1574.9
1961	396.1	501.8	286.4	396.8	607.4	1085.2
1962	453.7	603.6	323.8	465.4	833.1	1639.6
1963	591.3	804.5	344.1	497.2	978.3	1510.1
1964	624.7	836.3	357.6	519.0	902.8	1169.4
Cumulative Growth Rates (Per Year)						
	11.38%	13.31%	7.78%	10.17%	13.82%	15.56%
% Growth During 1948-64						
	524.7%	736.3%	257.6%	419.0%	802.8%	1069.4%

Contd...

(Table 3.9B contd.)

Year	BOARD		TOTAL PAPER & PAPERBOARD	
	Qty.	Value	Qty.	Value
1948	100.0	100.0	100.0	100.0
1949	106.7	115.3	107.2	119.9
1950	111.8	119.1	111.9	129.9
1951	134.4	183.6	136.4	176.3
1952	144.4	181.0	154.1	194.8
1953	141.1	136.8	151.2	188.6
1954	151.6	162.8	159.1	198.5
1955	209.8	233.1	205.2	256.3
1956	222.3	264.9	225.2	285.6
1957	287.8	350.9	276.7	348.9
1958	339.1	483.3	339.4	490.6
1959	358.2	458.2	362.6	507.4
1960	377.5	476.0	380.2	481.6
1961	395.6	509.5	384.7	510.9
1962	425.6	550.0	434.7	610.1
1963	460.2	621.5	522.9	748.8
1964	492.3	665.8	550.4	766.5
Cumulative Growth Rates (Per Year)				
	9.83%	11.80%	10.55%	12.73%
% Growth During 1948-64				
	392.3%	565.8%	450.4%	666.5%

Table 3.9C

Production of Paper & Paperboard (Quantity & Value)
(Excluding Newsprint)

Year	PRINTING & WRITING		WRAPPING PAPER		OTHER VARIETIES OF PAPER	
	Qty. 000 Tons	Value Rs. Laksh	Qty 000 Tons	Value Rs. Lakhs	Qty. 000 Tons	Value Rs. Lakhs
1948	56.6	636.2	16.2	139.6	2.58	38.4
1949	66.8	832.0	10.3	102.6	3.96	53.3
1950	67.9	870.0	13.7	164.7	2.88	50.4
1951	75.5	992.7	25.5	321.6	4.57	102.3
1952	94.8	1241.8	18.9	238.2	5.95	140.4
1953	89.7	1241.0	17.5	207.1	10.27	217.6
1954	91.0	1222.5	18.4	217.0	13.13	238.4
1955	113.6	1537.0	22.6	268.2	17.01	339.5
1956	129.4	1743.4	27.6	335.8	13.91	297.8
1957	141.6	1930.8	33.9	433.6	29.37	471.1
1958	163.3	2610.6	35.2	452.0	30.56	669.2
1959	193.0	3009.2	53.3	618.6	28.80	626.7
1960	219.0	2940.2	43.6	390.6	25.08	604.5
1961	224.0	3192.7	46.5	554.0	15.70	416.5
1962	257.0	3840.1	52.5	649.6	21.53	629.3
1963	334.8	5118.3	55.8	694.1	25.29	579.6
1964	353.7	5320.4	58.0	724.5	23.33	488.8

(Table 3.9C contd.)

	BOARD		TOTAL PAPER & PAPERBOARD	
Year	Qty.000Tons	Value Rs.Lakhs	Qty.000Tons*	ValueRs.La
1948	34.3	251.5	109.8	1065.6
1949	36.6	290.0	117.7	1277.8
1950	38.4	299.4	122.8	1384.5
1951	46.1	461.6	149.7	1878.2
1952	49.5	455.2	169.2	2075.7
1953	48.4	344.0	165.9	2009.8
1954	52.0	409.5	174.6	2115.0
1955	72.0	586.1	225.2	2730.8
1956	76.3	666.0	250.0	3043.0
1957	98.8	882.4	303.7	3717.9
1958	116.4	1215.3	345.4	4947.0
1959	122.9	1152.1	397.9	5406.6
1960	129.6	1196.9	417.2	5132.1
1961	135.7	1281.2	422.2	5444.4
1962	146.0	1383.0	477.1	6502.0
1963	157.9	158799	573.9	7979.9
1964	168.9	1674.3	604.1	8168.1

*Figs. may not add up because of rounding

Source: CMI & ASI Reports

Table 3.9D

Average Prices of Paper and Paperboard

	PRINTING & WRITING		WRAPPING PAPER		OTHER VARIETIES	
Year	Rs. Ton	Index 1952=100	Rs. Ton	Index 1952=100	Rs. Ton	Index 1952=100
1948	1123.4	85.7	860.7	68.3	1485.1	63.0
1949	1246.0	95.1	991.8	78.7	1345.9	57.1
1950	1282.2	97.9	1200.4	95.2	1751.7	74.3
1951	1315.2	100.4	1368.2	108.5	2236.6	94.8
1952	1310.2	100.0	1260.8	100.0	2358.8	100.0
1953	1383.1	105.6	1184.4	93.9	2118.1	89.8
1954	1343.2	102.5	1179.0	93.5	1815.9	77.0
1955	1352.6	103.2	1189.0	94.3	1996.2	84.6
1956	1347.6	102.9	1218.3	96.6	2140.9	90.8
1957	1363.4	104.1	1278.0	101.4	1604.3	68.0
1958	1599.2	122.1	1283.3	101.3	2189.5	92.8
1959	1559.4	119.0	1160.2	92.0	2176.0	92.3
1960	1342.6	102.5	895.6	71.0	2410.3	102.2
1961	1423.4	108.6	1192.6	94.6	2653.2	112.5
1962	149444	114.1	1236.9	98.1	2922.5	123.9
1963	1528.6	116.7	1243.7	98.6	2292.3	97.2
1964	1503.9	114.8	1249.2	99.1	1923.5	81.5

Contd ...

(Table 3.9D contd.)

Year	BOARD Rs. Ton	BOARD Index 1952=100	TOTAL PAPER & PAPERBOARD Rs. Ton	TOTAL PAPER & PAPERBOARD Index 1952=100
1948	732.8	79.8	971.0	79.1
1949	791.8	86.2	1085.7	88.5
1950	780.3	84.9	1127.2	91.9
1951	1000.8	108.9	1254.8	102.3
1952	918.8	100.0	1226.9	100.0
1953	710.8	77.4	1211.5	98.7
1954	787.1	85.7	1211.5	98.7
1955	814.0	88.6	1212.6	98.8
1956	872.9	95.0	1231.3	100.4
1957	893.5	97.2	1224.3	99.8
1958	1044.4	113.7	1403.5	114.4
1959	937.2	102.0	1358.7	110.7
1960	927.9	100.6	1230.0	100.3
1961	943.7	102.7	1289.5	105.1
1962	946.9	103.1	1362.9	111.1
1963	1005.4	109.4	1390.5	113.3
1964	991.1	107.9	1352.2	110.2

Source: Table 3.9C

Table 3.10A

Value Added & Related Series for Indian Paper Industry 1948-64

Year	Ex-Factory Gross Value of Output		Total Cost of Production		Value of Materials, Fuel, Power etc.	
	Rs. Lakhs	Index	Rs. Lakhs	Index	Rs. Lakhs	Index
1	2	3	4	5	6	7
1948	1102.0	100.00	908.7	100.0	644.7	100.0
1949	1295.9	117.6	1145.4	126.1	780.5	121.1
1950	1394.9	126.6	1240.6	136.5	781.5	121.2
1951	1974.5	179.2	1635.6	180.0	1081.2	167.7
1952	2143.7	194.5	1823.9	200.0	1257.6	195.1
1953	2052.0	186.2	1756.9	193.3	1170.3	181.5
1954	2174.9	197.4	1823.9	200.7	1230.5	190.9
1955	2775.3	251.8	2173.5	239.2	1470.3	228.1
1956	3107.6	282.0	2577.9	283.7	1713.7	265.8
1957	3830.1	347.6	3225.3	355.0	2125.8	329.8
1958	5359.7	486.3	4366.5	480.5	3030.2	470.0
1959	6352.0	576.4	5551.8	611.0	4009.3	621.9
1960	6880.8	624.4	6386.6	702.9	4507.8	699.3
1961	7299.2	662.3	6776.3	745.7	4807.4	745.7
1962	8474.2	769.0	7856.1	864.6	5619.4	871.7
1963	10589.6	960.9	9762.7	1074.0	6883.8	1067.8
1964	11327.6	1027.9	10591.2	1165.6	7305.9	1133.3

% Growth over 1948 level

927.9%	1065.6%	1033.3%

Cumulative Growth Rates Per year

14.69%	15.54%	15.35%

(Table 3.10A contd.)

Year	Depreciation Rs.Lakhs	Depreciation Index	Net Value Added Rs.Lakhs	Net Value Added Index
1948	47.6	100.0	409.8	100.0
1949	52.8	111.0	462.7	112.9
1950	84.6	177.7	528.8	129.1
1951	95.9	201.6	797.4	194.6
1952	95.5	200.7	790.5	192.9
1953	111.4	234.1	770.3	188.0
1954	108.5	228.0	835.9	204.0
1955	127.2	267.4	1177.8	287.4
1956	168.2	252.4	1225.7	299.1
1957	242.5	509.5	1461.8	356.7
1958	306.3	643.6	2023.2	493.7
1959	358.7	753.8	1978.8	482.9
1960	470.6	989.0	1902.3	464.2
1961	511.6	1075.1	1980.2	483.3
1962	468.9	985.3	2385.8	582.2
1963	736.7	1548.1	2969.1	724.6
1964	851.7	1789.7	3174.3	774.7
% Growth over 1948 level		1689.7%		674.7%
Commulative Growth Rate Per year		18.49%		12.80%

Table 3.10B

Profit Margin & Value Added as Percentage of Gross Output and Percentage Share of Labour in Value Added

Year	Percent share of wages salaries & benefits in value added	Percent share of 'workers' wages only	Profit margin as % of Gross output	Value Added as % of Gross Output
1948	54.23	37.79	17.54	37.18
1949	50.74	36.82	11.62	35.66
1950	49.84	36.63	11.07	37.94
1951	40.45	28.57	17.17	40.40
1952	41.88	29.04	14.93	36.89
1953	41.78	28.25	14.37	37.54
1954	40.35	26.47	16.14	38.45
1956	34.59	22.39	22.93	42.44
1956	38.61	24.43	17.05	40.41
1957	38.52	24.67	15.79	38.18
1958	34.35	22.24	18.53	37.76
1959	40.64	25.09	12.60	32.16
1960	49.29	31.30	7.18	27.65
1961	48.40	31.82	7.16	27.13
1962	46.02	29.62	7.29	28.16
1963	46.48	28.63	7.80	28.03
1964	47.64	28.36	6.49	28.01

(1) Revenue-cost margin includes profit and sellihg costs.
(2) 7% interest rate was assumed to compute the imputed interest on productive capital.

Source: CMI:ASI Reports.

Table 3.11A

Some Average Input-Output Variables for Indian Paper Industry 1948-64

Year	FIXED CAPITAL PER FACTORY		TOTAL MANHOUR WORKED PER FACTORY		NO. OF PERSONS EMPLOYED PER FACTORY	
	Rs. Lakhs	Index 1948=100	Thousands	Index 1948=100	No.	Index 1948=100
1	2	3	4	5	6	7
1948	15.34	100.0	1303.8	100.0	582	100.00
1949	16.96	110.54	1372.9	105.30	586	100.75
1950	26.06	169.87	1240.9	95.17	585	100.53
1951	27.34	178.17	1237.8	94.93	568	97.65
1952	27.62	180.02	1271.9	97.55	551	94.78
1953	27.20	177.31	930.0	75.16	488	83.98
1954	27.03	176.17	1018.8	78.14	539	92.64
1955	28.16	183.54	1132.2	86.83	550	94.64
1956	37.11	241.86	1238.9	95.02	610	104.92
1957	49.56	323.04	1280.5	98.21	655	112.58
1958	53.48	350.48	1434.5	110.02	732	125.76
1959	72.38	471.79	1687.8	129.45	774	133.17
1960	64.50	420.42	1369.9	105.07	618	106.19
1961	59.07	384.98	1154.1	88.52	552	94.83
1962	59.91	390.96	1004.9	77.07	475	81.70
1963	66.89	435.96	1099.0	84.29	496	85.25
1964	65.43	426,47	957.9	73.47	415	71.26
% Growth over 1948 level		326.53%		-26.53%		-28.74%

contd...

(Table 3.11A contd.)

Year	PRODUCTIVITY PER FACTORY Rs. Lakhs	PRODUCTIVITY PER FACTORY Index 1948=100	PRODUCTIVITY PER FACTORY Qty. Tons	PRODUCTIVITY PER FACTORY Index 1948=100
1	8	9	10	11
1948	28.34	100.00	2830	100.00
1949	33.32	117.60	3068	108.50
1950	34.14	120.47	3028	107.02
1951	45.72	161.36	3642	128.70
1952	50.02	176.51	4075	140.40
1953	41.04	144.83	3388	119.20
1954	44.42	156.76	3494	123.10
1955	51.54	181.88	4240	159.50
1956	58.34	205.90	4904	173.30
1957	66.09	233.22	5361	189.01
1958	87.50	308.79	5818	205.60
1959	110.27	389.13	7114	250.30
1960	81.57	287.86	6016	212.60
1961	81.24	286.71	5791	204.60
1962	72.83	257.01	4735	167.30
1963	82.84	292.34	5338	188.20
1964	72.67	256.45	4919	173.80
% Growth over 1948 level		156.45%		73.80%

Source: CMI & ASI Reports

Table 3.11B

Average Productivity of Capital and Labour Inputs & Capital - Labour Ratio In Paper Industry 1948-64

Year	PRODUCTIVITY PER UNIT OF FIXED CAPITAL		PRODUCTIVITY PER MANYEAR (8x300)mhs WORKED		PRODUCTIVITY PER PERSON EMPLOYED	
	Rs.*	Index 1948=100	Rs.	Index 1948=100	Rs.	Index 1948=100
1	2	3	4	5	6	7
1948	0.68	100.00	5216	100.00	4869	100.00
1949	0.73	106.38	5826	111.68	5684	116.73
1950	0.49	70.92	6602	126.57	5835	119.83
1951	0.62	90.56	8875	170.14	8061	165.55
1952	0.67	98.05	9438	180.94	9068	186.23
1953	0.56	81.68	10051	192.70	8397	172.45
1954	0.61	88.99	10465	200.62	8239	169.21
1955	0.67	97.82	10926	209.45	9358	192.18
1956	0.58	85.13	11303	216.69	9556	196.24
1957	0.49	72.19	12386	237.46	10087	207.16
1958	0.60	88.11	14640	280.67	11956	245.54
1959	0.56	82.48	15429	295.78	14228	292.19
1960	0.49	68.47	14291	273.98	13200	271.08
1961	0.51	74.47	16888	323.76	14722	302.34
1962	0.45	65.82	17393	333.45	15317	314.56
1963	0.46	67.06	18046	345.96	16699	342.94
1964	0.41	60.13	19563	375.03	17523	359.87
Net Change over 1948		-39.87%		275.03%		259.87%

Note:-*Fixed capital employed in production has been taken 2.7 times the stock of it for each year, taking into consideration three shifts working day for the industry.

(Table 3.11B contd.)

Year	FIXED CAPITAL (BOOK VALUE) PER WORKER*		FIXED CAPITAL (BOOK VALUE AT CONSTANT PRICES) PER WORKER*	
	Rs.	Index 1948=100	Rs.	Index 1948=100
1	8	9	10	11
1948	6006	100.0	9556	100.0
1949	8670	108.3	9942	104.0
1950	13387	167.2	15104	158.1
1951	14647	183.0	14444	151.1
1952	15393	192.3	15386	161.1
1953	17075	213.3	17131	179.3
1954	15720	196.4	16106	168.6
1955	15890	198.5	16899	176.8
1956	19324	240.2	19277	201.8
1957	24152	301.8	23314	244.0
1958	23436	292.8	21494	224.9
1959	29749	371.7	27444	287.2
1960	33018	412.4	28709	300.4
1961	33242	415.3	28188	295.0
1962	39685	495.8	32776	343.0
1963	43286	540.8	33945	355.2
Net change over 1948		541.1%		301.9%

Note:- *Fixed capital employed in production has been taken 2.7 times the stock of it for each year, taking into consideration three shifts working day for the industry.

(Table 3.11B contd.)

Year	CONSUMPTION OF ENERGY* PER 1000 MAN HOURS WORKED (COAL EQUIVALENTS) T		CONSUMPTION OF ENERGEY* PER TONNE OF OUTPUT (COAL EQUIVALENTS)	
	Qty. Tonne	Index	Qty. Tonne	Index
1	12	13	14	15
1948	7.75	100.0	3.52	100.0
1949	7.56	98.7	3.33	94.7
1950	0.37	108.0	3.37	95.8
1951	10.53	135.9	3.52	100.0
1952	10.27	132.5	3.15	89.5
1953	10.84	139.8	3.08	87.5
1954	9.47	122.2	2.71	77.0
1955	10.17	131.2	2.67	75.8
1956	11.70	150.9	2.91	82.7
1957	11.92	153.8	2.80	79.5
1958	11.62	150.0	2.82	80.1
1959	11.57	148.0	2.70	77.0
1960	10.91	140.8	2.44	69.3
1961	12.68	163.6	2.48	70.5
1962	11.36	146.7	2.37	67.3
1963	11.40	147.0	2.31	65.6
1964	10.40	134.2	1.99	56.5
% Growth over 1948 level		34.2%		-43.5%

*Conversion factors used in computing Energy consumption are as follows:

**1 Tonne of Wood = 0.5 Tonne of Coal
1 Gallon of fuel oil = 0.00595 Tonne of Coal
1000 KWH of Electricity = 0.125 Tonnes of Coal

**Source: United Nations: Statistical Year Book 1967, Page 777

CHAPTER 4

Demand for Paper and Paperboard in India (1950-1964)

The objective of this chapter is to estimate a set of demand functions for different categories of paper and paperboard in India covering the period 1950-51 to 1964-65. The chapter will have two main parts: Section I and Section II. In section I, we shall be dealing with the historical trends in consumption of different categories of paper and paperboard in India; while in Section II, we shall be dealing with the specification and estimation of the demand functions for them. The main conclusions derived from the analysis will be summarised at the end of the chapter.

4.1 Classification of the Categories of Paper and Paperboard:

The commodity known as 'paper and paperboard' is a heterogeneous group of a large number of varieties which have a wide scope of uses in modern civilization. They are used as inputs in the industrial and business sectors and as consumers goods in the household sector. We have attempted to list some important varieties of paper and paperboard and their uses. This is given in the

appendix of chapter 1. The list contains 164 varieties and there may be some more. For the purpose of demand analysis, all these varieties of paper and paperboard may be grouped together in a few categories on the basis of their uses. The most common classification that is being followed now-a-days by most of the countries and the United Nations (1960) is as follows:

1. Newsprint
2. Printing and Writing paper
3. Other papers

and 4. Paperboard

These four categories of paper and paperboard may be further condensed into two, namely, the 'cultural papers' and the 'industrial papers! Cultrual papers are newsprint and other printing and writing papers which are used in printing and writing works. On the other hand 'industrial papers' are used in business and industries for various purposes other than printing and writing work such as packaging of goods and as raw material for certain products. However, for the empirical work the first classification consisting of the four distinct categories of paper and paperboard is preferred since it displays greater degree of uniformity interms of the uses of paper and paperboard than the second one. We will

also use this classification in the present chapter which deals with the econometric analysis of the demand for paper and paperboard in India.

For each of the four categories of paper and paperboard (except newsprint) mentioned above, we have derived two alternative consumption series covering the period 1950-51 to 1964-65. The first series which we have called by the name of 'CMI: ASI series', is based on the CMI and ASI production statistics while the second one which we have called as 'M.S.P.S. Series', is based on the Monthly Statistics of Production data. Detailed information regarding the scope, coverage, and other related terms involved in construction of these series, is given in Chapter 2 of the study. We will use both of them in the analysis of the demand for paper and paperboard in India, but the conclusions will be drawn from the CMI: ASI series since it covers the entire industry. The second series (i.e., MSPS series) is taken to supplement the findings from the previous one.

Section I

4.2 Growth of the Demand for Paper and Paperboard in India (1950-1965): Historical Review:

Since 1950 we have made remarkable progress in

in fields like education, business and industries, where bulk of the paper and paperboard is consumed. The literacy of the masses increased from 17% in 1951 to 29.4%. in 1971. The number of students enrolled in schools and colleges increased from 255 lakhs per year in 1950-51 to 650 lakhs in 1964-65. Similar trends have been observed in the growth of the national income, income from the business and industrial sectors and in the per capita income of the nation (Ref: Table 4.14). These factors have exerted an upward trend in the demand for all categories of paper and paperboard during the period 1950-51 to 1964-65. Table 4.1 shows the extent of growth in the consumption of paper and paperboard during this period. From the table, we find maximum growth in the printing and writing papers which exclude the newsprint. Consumption of this category of paper has increased by more than 364% during the period which gives an average annual rise by 10.8% (Ref: CMI:ASI series in the Table). Consumption of paperboard comes next in growth with 295% increase at the rate of 9.6% per annum. Growth in newsprint consumption has been lowest during the period. It increased only by 72% at the rate of 3.7% per annum. Total consumption of paper and paperboard with and without newsprint has increased by 233 and 314 percent respectively. Similar trends in the consumption of different groups of paper and paperboard have been found in the M.S.P.S.

Table 4.1

Growth in Consumption of Paper & Paperboard
(1950-51 to 1964-65)

Name of the categories	Consumption(000 Tons) 1950-51	Consumption(000 Tons) 1964-65	Total Growth % (over 1950-51)	Growth per Year %
CMI:ASI Series:				
1. Total paper & Paperboard	227.7	758.8	233.2	8.3
2. Total Paper and Paper-board (Excluding Newsprint)	151.5	627.5	314.2	9.9
3. Printing & Writing paper (Including Newsprint)	154.7	495.8	220.5	8.1
4. Printing & Writing paper (Excluding Newsprint)	78.5	364.5	364.3	10.8
5. Wrapping & other paper	30.0	93.0	210.0	7.8
6. Board (All kinds)	43.0	170.0	295.0	9.6
7. Newsprint	76.2	131.3	72.0	3.7
MSPS Series:				
1. Total paper & Paperboard	210.0	642.1	201.5	7.6
2. Total Paper and Paper-board (Excluding Newsprint)	137.8	510.8	270.7	9.1
3. Printing & Writing paper (Including Newsprint)	158.0	456.9	189.2	7.4
4. Printing & Writing paper (Excluding Newsprint)	81.8	325.6	298.0	9.6
5. Wrapping & other paper	32.5	100.8	210.0	7.8
6. Board (All kinds)	23.5	84.4	259.1	8.9
7. Newsprint	76.2	131.3	72.0	3.7

series, only magnitudes are somewhat lower because they do not take full production of the industry into account. Yearly fluctuations in the consumption of all five categories of paer and paperboard can be seen from the graphs and tables given in the appendices of this chapter.

Domestic supply of the paper and paperboard except newsprint has increased continuously to meet the growing demand in India. Before the beginning of the Plans, India used to import considerable amount of paper and paperboard (Ref: Table 4.15) but gradually by the expansion of the industry, imports have been reduced to almost zero level except of newsprint. Production of newsprint in India started in 1956-57. But, by the end of 1964 the industry could be able to meet only 25% of the demand (Ref: Table 3.2, Chapter 3). The bulk of newsprint demanded in India is being imported even today. Low domestic production and shortage of the foreign exchange, restricted the growth of the consumption of newsprint in India in the past which has been only 3.7% per annum as compared with the growth of other varieties of paper and paperboard in shown in Table 4.1.

4.3. Pattern of the Demand for Paper & Paperboard in India 1950-1965:

The pattern of the demand for paper and paperboard in India for the period 1950-1965 is given in Table 4.2.

The percentage share of the printing and writing paper in the total consumption of paper and paperboard varied between 56.9 and 68 percent during the period 1950-1965. The share of the 'wrapping and other varieties' fluctuated between 12 to 19 percent and that of the boards between 18 to 16.4 percent (Ref: CMI: ASI wseries in the Table). As seen from Fig. 4.1 percentage share of printing and writing paper declined from 67.9 percent in 1950-51 to 61.2 percent in 1951-52. It increased to 64.1 and 64.7 in 1952-53 and 1953-54 respectively. After that there has been a downward trend in it reaching the lowest limit of 56.9 percent in 1958-59. Since then it went on increasing and reached the level of 65.7% in 1963-64. The percentage share of wrapping and other papers has been rising cyclically till 1957-58 after that it declined contineously reaching the lowest limit of 12.2% in 1963-64. The percentage share of the paperboard has also shown similar trends. Percentage shares of these three categories of paper and paperboard calculated from the M.S.P.S. series (Ref: Fig. 4.1(b) display similar trends as in the C.M.I: A.S.I: series, but their magnitudes differ. Since MSPS series of the paperboard excludes some varieties manufactured in the small scale sector of the industry, it has low percentage share than the corresponding CMI: ASI series. As a result of this other two categories of paper and paperboard have higher

- contd on p 152

Table 4.2

Structure of Demand for Paper and Paperboard

Year	Printing & Writing Papers %	Wrapping & others %	Board %	Total %
CMI:ASI Series				
1950-51	67.9	13.2	18.9	100.0
1951-52	61.2	17.8	21.1	100.0
1952-53	64.1	15.1	20.8	100.0
1953-54	64.7	16.2	19.1	100.0
1954-55	61.3	18.6	20.1	100.0
1955-56	60.0	16.7	23.4	100.0
1956-57	60.6	17.3	22.1	100.0
1957-58	59.1	17.6	23.3	100.0
1958-59	56.9	16.7	26.4	100.0
1959-60	59.9	15.5	24.6	100.0
1960-61	60.8	14.5	24.5	100.0
1961-62	62.4	13.6	24.0	100.0
1962-63	63.7	12.7	23.6	100.0
1963-64	65.6	12.2	22.2	100.0
1964-64	65.3	12.3	22.4	100.0

contd...

(Table 4.2 contd.)

Year	Printing & Writing Papers %	Wrapping & Others %	Board %	Total %
MSPS Series:				
1950-51	74.2	15.3	11.0	100.0
1951-52	67.9	19.7	12.2	100.0
1952-53	72.2	16.5	11.3	100.0
1953-54	73.8	16.6	9.6	100.0
1954-55	72.4	16.1	11.5	100.0
1955-56	68.6	17.8	13.6	100.0
1956-57	67.5	19.6	12.9	100.0
1957-58	67.3	20.0	12.8	100.0
1958-59	66.5	18.8	14.7	100.0
1959-60	68.8	17.4	13.8	100.0
1960-61	69.4	17.7	12.9	100.0
1961-62	70.2	16.8	13.0	100.0
1962-63	70.0	16.2	13.4	100.0
1963-64	72.0	15.2	12.9	100.0
1964-65	71.2	15.7	13.1	100.0

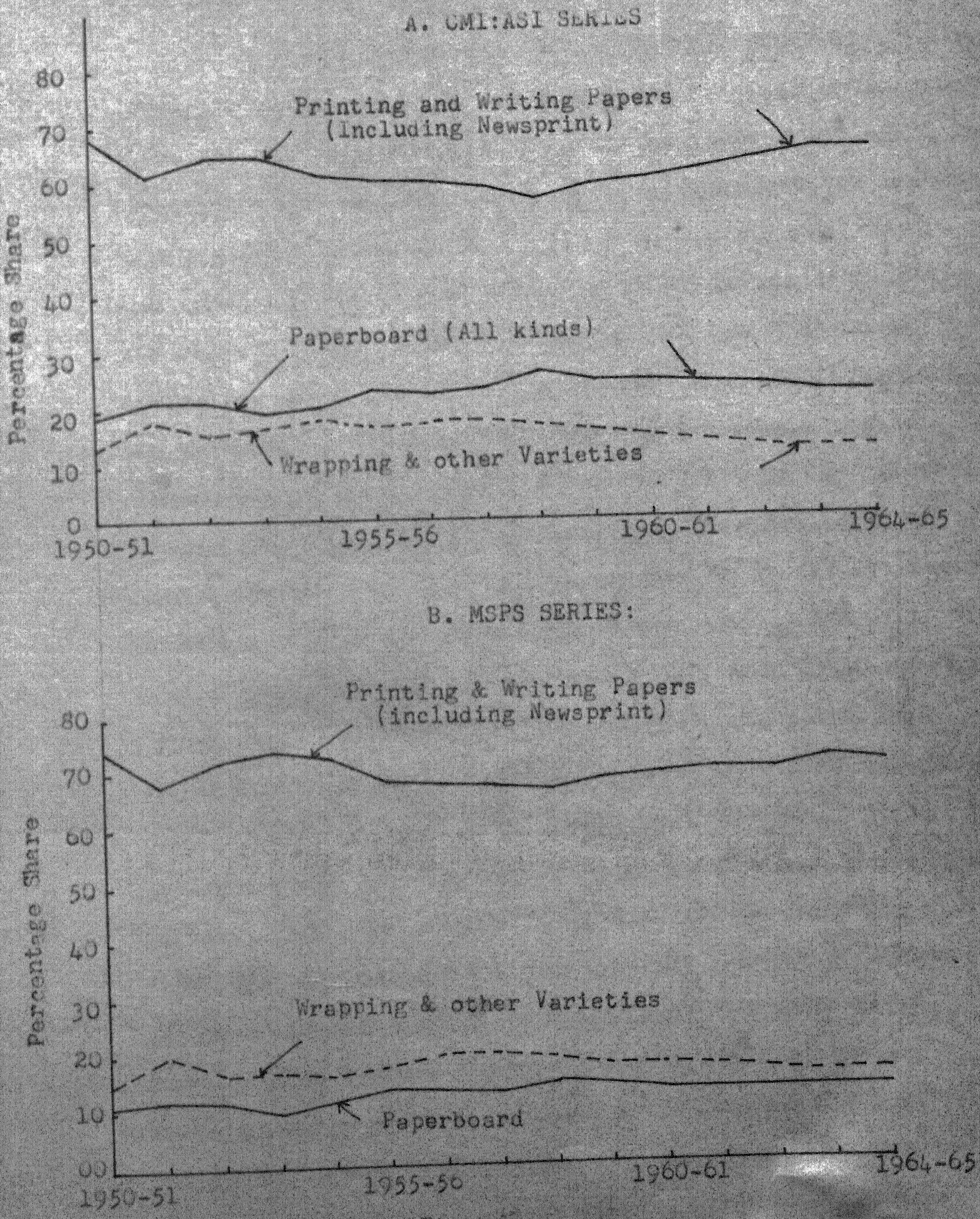

Fig.4.1

STRUCTURE OF DEMAND FOR PAPER AND PAPERBOARD
% SHARE OF DIFFERENT VARIETIES IN
TOTAL CONSUMPTION

percentage shares than their CMI:ASI counterparts.

From the changes in the percentage shares of different groups of paper and paperboard in total consumption, we do not find any definite trend in the pattern of demand for paper and paperboard in India. It may, therefore, be assumed fairly stable having about 65% share of the cultural papers and remaining 35% of the industrial paper (wrapping & others and board). This is quite different from the pattern of demand for paper and paperboard in the developed countries. For example, in USA consumption of the industrial papers constitute about 65% share and remaining 35% by the cultural papers' (Hoffman 1958, p.11). This is just opposite of the demand structure of paper and paperboard in India. Similarly in Western Europe the ratio between the consumption of industrial papers and cultural papers has been 60.40 percent in the years 1950-62 (Åberg 1968, p.37). This pattern of demand for paper and paperboard in these countries was fairly stable during the period 1950-1965 (Sundelin 1964, pp.338-339) In America and other developed countries the demand for the cultural papers has tended to be less income elastic with the attainment of the cent percent literacy. Their population growth is almost zero or even negative. So there is no further scope for the growth in demand for printing and writing papers in these countries. The demand for the industrial papers on the other hand has shown high income elasticity which continues as the industrial or economic growth is unlikely to reach any technical ceiling . In our

country literacy is only about 29.4% (1971) which is on a rising trend. Moreover population is growing rapidly. Larger share of the cultural papers in the total consumption of paper and paperboard is, therefore, natural under such conditions which may continue till we attain full literacy and check our population growth. Demand for the industrial papers will also continue to be growing because of the expanding business and industrial sectors. Considering the growth in the literacy, population, business and industrial sectors the existing pattern of the demand for paper and paperboard in India may continue in the near future.

We have already mentioned the factors affecting the demand for paper and paperboard in India such as rise in the literacy or the number of students; expansion of the business and industrial sectors; increase in the percapita income; domestic availability of paper and paperboard and substitutes for some varieties of paper and paperboard and so on. The change in the demand for a particular category of paper and paperboard in India during a particular period in past was the combined effect of all these factors but what was the contribution of each of them in difficult to be known unless we estimate a demand function for it. In the next section we will therefore estimate a set of the demand functions for different categories of paper and paperboard in India using the time-series data covering the period 1950-1965. By doing so we will be able to test the relevance of the above mentioned factors and their contribution in affecting the demand for paper and paperboard in India.

SECTION II

4.4 Econometric Analysis of the Demand for Paper and Paperboard in India 1950-1965:

4.4.1 Specification of the Models:

As mentioned in Section I of this chapter, paper and paperboard have several uses. They are used in consumer sector for educational and cultural purposes and in business and production sectors, as a packaging material, as an input in the industrial processes and as a medium for information, records and general administration and so on. Notwithstanding these widespread uses, there are certain features common to all of them which are very much relevant to the econometric analysis of the demand. One such common characteristic is that in nearly all sectors except printing and allied industries the total cost of paper consumption constitute a very small proportion of the consumer's total expenditure. This can be seen from the input-output tables of different countries. Another important characteristic of paper and paperboard consumption is reflected by its essential role in the society as a medium for writing for which no substitutes are available so far. This characteristic tends to make the consumption of paper and paperboard inelastic with respect to the price and other demand factors such as advertisement, taste preferences, etc., from the individual consumers'

point of view. For him the consumption of paper and paperboard may be treated as customary or continuous unaffected by short-run fluctuations in income and prices.

The selection of the explanatory variables to be used in fitting a demand function for paper and paperboard must be based on the above characteristics of paper and paperboard consumption. Such variables may be as follows:

1. A measure of the total economic activity in society is the most natural explanatory variable which takes into consideration both, the widespread uses of paper and paperboard and its complementary nature in relation to many other economic transactions.

2. Total number of inhabitants in a country would be another natural explanatory variable taking care of the widespread uses of paper and paperboard in the households which may be independent of the economic activity of a nation.

3. In addition to these two variables, consumption of the paper and paperboard may be affected by the changes in peoples' living habits and environments. For this, assuming that the effect of such factors on demand for paper varies with time, a trend factor would be a suitable choice as an explanatory variable.

4. Price may be taken as an explanatory variable.

But, as already pointed out, this is not likely to be significant since there are no substitutes especially for printing and writing papers. For some varieties such as wrapping papers for which some substitutes are available, it may of course be relevant, so for the present we include it as an explanatory variable.

With the above explanatory variables the demand function for paper and paperboard may be stated simply as;

$$D_i = f_i\ (y,t,N,P_i,\ u) \qquad (1)$$

D_i is the consumption of product group i;
y, is a measure of economic activity;
t, denotes the trend; N, the population; P_i is a price index for the product group i; and u, is a random variable with zero expectation to represent the variables that are not explicitly accounted in the specification.

Alternatively, a more general model may be specified in the light of stricter theoretical requirements based on the general postulates concerning consumer and producer behaviour. Assuming that consumer behaviour aims at utility maximization, it is possible to derive the demand functions according to which the consumption of a particular group of paper and paperboard is determined by the income of the consumer, its price and prices of all

other commodities with which the consumer is confronted. Similarly, based on profit maximization postulate, consu ption of the same group of paper and paperboard in the producer sector as input, is determined by the price of output for which paper is used as input and the prices of all other inputs used in its production. Adding up the total consumers' demand and the total producers' demand for that group of paper and paperboard, the aggregate demand (D_i) for it may be expressed as a function of total national income (y); price of the product group i. (P_i); prices of all other commodities and services, Z_j (j = 1,n); population (N); and the trend (t). Expressed in functional form, it is as follows:

$$D_i = f_i\ (y, N, P_i, Z_j, t, u) \qquad (2)$$

This detailed specification of the demand function adds nothing much to what was obtained with (1), because seeing the nature of the consumption of paper abd paperboard variables Z_j (j = 1,n) may not be very much relevant. Prices of all other commodities and services are unlikely to affect the consumption of paper and paperboard due to its very small proportion in the total expenditure. For the analysis of demand for paper and paperboard, model (1) which excludes the prices of all other commodities and services (Z_j) is more relevant than the model (2). In fact the two models are equivalent on dropping Z_j from

the second one. Therefore, further explorations in the specification and formulation of the final demand function for paper and paperboard in India will be based on this.

We have simply enumerated the catalogue of the explanatory variables without finding out any thing more specific about the form of the function, the level of aggregation at which it is to be fitted and the relevance of the explanatory variables at this level of aggregation. We will do this now. First we will take up the problem of aggregation or grouping of different varieties of paper and paperboard to fit the demand functions and then select the explanatory variables for them. Finally, we will come to the form of the function and other related problems.

Since paper and paperboard constitute an extremely heterogeneous group in terms of use, a single equation demand function for the entire group of this commodity may not be useful from the point of view of empirical analysis. For example, if it is used in prediction of the future demand, we will get total quantity of paper and paperboard which is not meaningful unless we know the types of paper required for various uses. The meaningful analysis of the demand for paper and paperboard is possible only when it is disaggregated in accordance with the uses for which there may be different explanatory variables. The degree of disaggregation may be high or low depending upon the

availability of statistical data. Customarily the disaggregation is carried on in terms of the four distinct categories as we have mentioned earlier viz., newsprint, other printing and writing papers, wrapping and other papers and paperboard. To fit the demand function for paper and paperboard in India, we will follow this grouping. For each of them, as well as for the total consumption of paper and paperboard, we will first formulate the demand functions and then estimate them using the time-series data. As we have seen above, the explanatory variables which are included in the demand function for paper and paperboard are'nation's total economic activity', population, price and trend. Some of these four explanatory variables may not be relevant in the Indian situation. We will, therefore test their validity one by one which follows:

(i) <u>National Income</u>:

National income is the most appropriate measure of the total economic activity of a nation. The question arises whether the whole of the national income should be taken as an explanatory variable for the demand analysis of paper and paperboard or only a part of it which comes from the paper using sectors such as industry, trade and services. From the input-output tables of different countries we find almost negligible consumption of paper and paperboard as input in the agriculture. The income

from the agricultural sector may, therefore, be excluded from the national income. Remaining part of it which we call as 'non-farm national income' seems to be a better measure of the total economic activity of a nation for fitting the demand function for paper and paperboard. For the consumption of paper in the rural household sector and other sectors for educational purpose, the population or number of students or literates, may be taken as an explanatory variable. This does not debar us from using the'non-farm national income' as a variable representing the industrial uses of paper and paperboard. However, if the population and number of students are insignificant variables, then national income is 'of course' a relevant variable for the demand analysis of the printing and writing papers. In that case it takes care of the uses of this category of paper in the industrial as well as in the household sectors of the nation. For remaining categories (Paperboard and wrapping & other papers), 'non-farm income' remains relevant explanatoty variable as before.

There is another important question associated with the use of national income or'non-farm national income' as an explanatory variable for the demand analysis especially in the case of printing and writing papers. We know that the demand for education which in turn creates demand for the printing and writing papers, depends in part

upon a stream of past and future income. In Friedman's terminology we call it 'permanent income' (Friedman, 1957). We may, therefore, take a measure of the 'permanent national income' in place of the national or non-farm national income for fitting the demand function for this category of paper. For the other categories, the concept of 'permanent income' is somewhat irrelevant because their demand is tied up with the current business and industrial activities.

The national income and its variants are relevant explanatory variables for the demand analysis of paper and paperboard in all conditions whether a country is developed or underdeveloped. We will, therefore, take it in the specifications of the demand functions for paper and paper-board in India.

(ii) Population:

Total number of inhabitants is an important demand factor for paper, but, the whole of it is relevant only in the developed countries where there is cent percent literacy and paper is used for toilet purposes etc. In a country like ours where literacy is very low, the population of literate inhabitants is a relevant demand factor for paper and paperboard. If the proportion between increase in the literacy and increase in the population remains constant, then of course, total population may be taken as a factor. But this is unlikely in this country

where a number of other factors beside increase in the population affect the literacy of the masses. We may assume a situation when the population remains constant but the literacy increasing due to impact of increasing income, mass communication and general awareness about it. It is, therefore, the literacy which is relevant as a demand factor for paper and not the total population of the country.

At a point of time, total number of the literates within a country may be divided into two parts: students and non-students. Non-students are the persons who earn income in various ways. They can be excluded from the total number of literates because income and trend variables already take care of the consumption of paper and paperboard by them. This leaves only the number of students enrolled in schools and colleges as a possible demand factor for paper and paperboard. Moreover in a country like ours income is an important factor affecting the education, so that there is every possibility that the number of student may not be an independent demand factor for paper and paperboard. However, we may include the number of students in the catalogue of the explanatory variables for fitting in the demand functions for paper and paperboard assuming it as an exogeneous variable. If it gives insignificant coefficients, we will drop it from the analysis.

(iii) Prices:

The demand for paper and paperboard may not be very much price sensitive in view of its characteristics which we have discussed above. However, for some varieties of paper and paperboard such as wrapping paper and paperboard for which close substitutes are available, price may be a significant demand factor. At this stage we, therefore, do not conclude on a priori grounds that prices of different categories of paper and paperboard were insignificant factors affecting the demand for them in India during the period under review. We leave it to be tested in the empirical analysis of the demand functions for them.

(iv) Substitutes:

For newsprint and printing and writing papers there are no substitutes available, but, for packaging papers there are of course some substitutes such as jute products, coarse cloth, old newspapers and polyethylene sheets. Jute products and coarse cloth are not serious rivals for packaging papers since they are used for packaging the products such as food grains and cement which cannot be packaged with paper because of its low strength. Polyethylene is the main substitute for packaging paper. Recently the consumption of polyethylene in India has gone up because of its domestic availability (Ref: Fig. 4.5, P. 217). The quantity

of polyethylene consumed or its price may, therefore, be a relevant demand factor for packaging paper. But such series are not available for the whole period under review. In view of this paucity of data on polyethylene prices or quantity consumed and almost non-competitive nature of other two substitutes viz., jute products and coarse cloth, with the packaging paper, we have not taken the substitution into account in fitting the demand functions for this category of paper and paperboard.

(v) Trend:

The trend may be an important explanatory variable for the demand analysis of paper and paperboard in the situation that we had in India during the period 1950-1965. The expansion in the mass communication media and educational facilities might have caused greater awareness for the education among the masses affecting the demand for paper and paperboard. The awareness for the education may be assumed to vary with time. Further, changes in tastes, paper packaging in place of old hessian packaging, increase in the tendency to read newspaper and travel fictions etc., modernnization and increase in paper work, etc., are some other factors which are assumed to vary with time. Therefore, the time trend which takes into account many factors, seems to be a relevant demand factor for paper and paperboard in India.

On the basis, of the arguments given above, the possible explanatory variables which may be used in fitting the demand functions for paper and paperboard in India are as follows:

Table 4.3

List of Explanatory Variables for Paper and Paperboard Demand in India

Commodity Group	Explanatory Variables
1. Total Paper and Paperboard	National Income or Non-farm National Income; Prices; No. of students and trend.
2. Printing and writing papers (Excluding Newsprint)	National Income or Non-Farm Income, Prices, No. of students and trend.
3. Newsprint	National Income or Nonfarm National Income, prices; No. of students and trend.
4. Wrapping and other papers	Non-farm National Income; Prices and Trend.
5. Paperboard	Non-farm National Income, Prices and Trend.

The two variables 'number of students' and 'trend' are purely exogenous. National income may also be assumed to be exogenous because the paper industry accounts for a very small proportion of total income formation in the country, so the fluctuations in the demand for paper and

paperboard may affect the income of the industry but not the national income. In India, during the period under study (1950-65) prices of paper and paperboard were not free to be determined by the demand and supply mechanism. They were rather fixed or controlled by the Government of India[1]. We can, therefore, take them as exogenous variables for fitting in the demand functions.

With the assumption of exogeniety for all explanatory variable shown in the table above, we can specify the demand function for each category of paper and paperboard in a single equation form. For example, for the total paper and paperboard, newsprint and printing and writing papers, the demand function can be specified as:

$$D_i = f_i(y, S, P_i, t, u)$$

i = 1,2,3; denotes the three categories of paper; and for the wrapping and other papers, and paperboard

$$D_i = f_i(y, P_i, t, u)$$

i = 1,2; denotes the two categories of paper.

where y is a relevant income variable, i.e. national income or nonfarm national income,

P_i is the Price Index for the Category i,

S is the number of Students,

1. From January 1960 prices of 24 common grades of paper and paperboard were controlled by the Government of India. Prior to that the prices of paper and paperboard were free to vary with the permission of the Government of India.

t is the trend

and u is a random error term.

The control on prices of paper and paperboard that we had in this country, particularly, during the Third Five Year Plan period, implies a disequilibrium market for the commodity., Inadequate supply of paper and paperboard might have restricted the consumption of paper and paperboard to low level during the period under study and hence, the estimates of the demand functions based on restricted consumption data may not reveal the true picture. But if we analyze the mode of consumption of paper and paperboard in India we will find it almost free from the constraints. Throughout the period under study (1950 to 1965) consumers in India were free to buy any quantity of paper and paperboard. Producers in the printing industry were also getting almost normal supplies of paper and paperboard except newsprint for which a system of the fair distribution was introduced from the beginning of the Second Five Year Plan. This contention i.e. adequate supply of paper and paperboard (except of newsprint) in relation to demand, is based on information given by some wholesale paper merchants of Kanpur city. Moreover, the following statements provide additional support to this, especially, for the Third Five Year plan period when we had statutory control on the prices of paper and paperboard in this country.

(1) "Production of paper has fallen short of the target envisaged. But the supply was adequate in relation to demand which did not increase at the rate as originally estimated. The production of newsprint was, however, considerably short of requirements, and in spite of foreign exchange shortage substantial imports had to be resorted to".--

--- (Planning Commission: "Fourth Five Year Plan". A Draft Outline; 1966, Page 252).

(2) "During the Third Plan period, the supply situation further deteriorated under the rising material cost. Besides, the demand began to develop for the first time signs of weakness. The purchasing power of the masses remained at low efficiency as their per capita income was virtually stationary throughout this period. The industry was confronted with a new phenomenon, namely sluggishness in demand which it never encountered in the past. The temporary cuts in production and the slow-down in the installation of new capacity could not make up for the slack in demand. There was a glut in the market which had to be liquidated by offering discounts to the prospective buyers".-(Economic & Research Foundation New Delhi; Paper and Paperboard: Prospects for 1975; page 25).

From the above statements we are convinced that there was no disequilibrium in the market for paper and paperboard in the country when prices of paper and paperboard

were controlled. The domestic production of paper and paperboard was, however, inadequate but taking in view the important role of paper and paperboard in the society, the Government of India adopted a policy of liberal imports and thus maintained the balance between demand and supply of paper and paperboard throughout the period under review. Since paper as a writing surface is indispensable means for education and communication, the purpose of control on its prices in the country was to safeguard the interests of the consumers by providing cheap books and writing paper in the situation of inadequate domestic production and from an apprehension of the rise in the prices of paper and paperboard because of the shortage of foreign exchange to import them from abroad. Thus, taking the above facts into consideration the demand functions fitted with the consumption data of 1950-1965 period for different categories of paper and paperboard may be taken free from the supply constraints. In other words, they are presumed to express the unrestricted demand for paper and paperboard except for newsprint.

<u>Choice of the Function</u>:

The relationship between the variables describing the demand function for a particular category of paper and paperboard may be linear or nonlinear. The coice of this relationship depends upon the assumption regarding the elasticity of demand for that category of paper and paperboard

with respect to the related explanatory variables. A linear relationship may be assumed which implies that the elasticity of demand with respect to a particular explanatory variable varies with the level of that variable. Alternatively, a nonlinear relationship of logarithmic type may be assumed which gives the constant elasticity of demand. Other non-linear relationships such as exponential type may also be possible in which the elasticity of demand no longer remains constant. The problem is what should be the most appropriate functional form of the relationship between the variables describing the demand function for a particular category of paper and paperboard in India. On a priori grounds, it is difficult to say any thing precisely regarding this. However, from the existing empirical studies on demand functions for paper and paperboard in different countries, we get over-whelming evidence in favour of the logarithmic form. This may also be true for this country, but we do not rule out the possibility of other functional forms. The empirical analysis of the demand functions for different categories of paper and paperboard in this country will itself settle this issue later on in this chapter. Before proceeding with this empirical analysis we will have a brief survey of the existing studies on demand analysis for paper and paperboard in India and other parts of the world. It will help us in understanding the true nature of the demand functions for paper and paperboard in India.

4.4.2 Analyses of Demand for Paper and Paperboard: A Survey:

Certain results concerning the demand for paper and paperboard have been obtained as secondary findings in the studies, many of which are extremely extensive. This is particularly true of the input-output analyses which have provided valuable statistical information in this respect[1]. In the present section, however, we shall be mainly concerned with the special econometric studies that have been conducted on the demand for paper and paperboard in different parts of the world.

(i) UN/FAO Studies:

The most commendable work in the field of demand analysis for paper and paperboard has been done by the United Nations and its allied agencies like the F.A.O. and the U.N.E.S.C.O. These world organizations have conducted extensive studies on the demand and supply prospects of paper and paperboard in different parts of the world, especially, in the underdeveloped or developing regions such as Latin America, Africa, Middle East, Asia and the Far East[2]. In these studies the demand for paper and paperboard has been

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1. Some important studies on input-output analyses are as follows : Leontief (1941); Stone (1954); Arrow & Hoffenberg (1959); U.N.I.D.O (1969), & Carter & Brody (1970).

2. UN/FAO/E.C.L.A. (1954); U.N./F.A.O. (1955,1960,1962,1967), U.N.E.S.C.O. (1954, 1961).

expressed in terms of percapita for which the percapita income has been found as the most relevant explanatory variable. The form of the relationship has been found varying from study to study. For example in 1954 study by F.A.O. and E.C.L.A. concering the potential for development of pulp and paper industry in Latin America, percapita demand was explained in terms of the constant elasticity demand function:

$$\left(\frac{D}{N}\right)_t = a \left(\frac{y}{N}\right)_t^{\beta}$$

Where D is the quantity of paper and paperboard consumed;

y is a measure of the total National Income

and N is the population.

This is the logarithmic form of the demand function and it has also been followed by the OECD (1962) for the analysis of the consumption of paper and paperboard in its member countries. However, in 1955 study by the UN/FAO for the Latin America countries, the logarithmic form of the relationship between percapita consumption of paper and paperboard and percapita income, has been replaced by a second degree parabola. In other studies by the UN/FAO it was assumed as a 'log-normal' relationship between the two variables. In the UNESCO (1954,1961) studies the variables have been taken in aggregate forms rather than percapitas and inaddition to the national income as an explanatory variable, other variables such as literacy, educational facilities,

size of domestic paper production and political conditions have been included in the demand relationship for paper and paperboard. The work is statistical in nature and no regorous attempts have been made to construct econometric models for the demand analysis by the UNESCO.

For Asia and the Far East the study conducted by The FAO (1962) appears to be very much interesting. This study has covered almost all the aspects of pulp and paper industry in different countries of the region including India. For forecasting the demand for paper and paperboard, a log-normal relationship between the percapita consumption of paper and paperboard and the percapita income has been established for each country in the region. The chief characteristic of the log-normal function is that it is an "$\int$" shaped (singuriod) curve which, as income rises, gradually approaches a saturation level of consumption. This means, in effect, that at higher income demand for paper will grow more slowly in relation to economic growth than at lower incomes. The FAO assumed this pattern of growth in the consumption of paper and paperboard in this region. Its study is based on the post-war consumption of paper and paperboard and income data for all the countries of the region. According to the FAO, the post-war decade was a period of abnormal growth in paper and paperboard consumption which declined heavily during the War. The main contention

of the FAO in assuming a log-normal demand relationship for the countries in Asia and the Far East region was that the rate of growth in consumption of paper and paperboard which was higher in the post-War decade, would be declining in the next decade and the abnormality in it caused by the War would go off. Further, to avoid the over estimation of paper and paperboard consumption in the long run, the trend of the so called 'abnormal' post-War decade, has not been considered by the FAO in fitting the demand functions for paper and paperboard in the Asian and the Far East countries.

The model of the demand function suggested by the FAO is a crude one. It can be applied to the developed countries, but, not to a developing country like India. In India the higher consumption of paper and paperboard in the post-War decade was not due to the War created abnormality, but it was due to,general craze for the education and thus for paper. The growth of income in India during the past 20 years was due to the planned efforts of the nation as a whole. In the near future the national income may increase even at a faster rate, living standards of masses may improve under the influence of modern time. It is, therefore, necessary to incorporate factors such as literacy and time trend in the demand function for paper and paperboard for the country. The FAO, however, admitted the limitation of their study and suggested for the modification in the demand

functions for paper and paperboard suiting to the individual countries. Further, so far we have not come across the saturation level of the consumption of paper and paperboard in any country of the world. For some varieties of paper like writing paper there may be of course, a saturation level of consumption in developed countries because of the cent percent literacy and the low population growth. For a country like India where population is growing at a higher rate, number of students in schools and colleges is growing at faster rate than population, business and industrial sectors are expanding day by day, the demand for paper and paperboard may grow faster than income. The assumption of log-normal demand relationship, therefore, appears to be a dim possibility at least in the coming near future.

(ii) American Studies:

On the basis of percapita income the United States is the richest country in the world. It also has on its credit the maximum record of the percapita consumption of paper and paperboard in the world. Between 1900 and 1963 the annual percapita consumption of paper and paperboard in the USA rose from 26 to 199 Kg., an eight fold increase in 60 years. This increase in the demand for paper and paperboard in the United States has been found to be closely

linked with the expansion of industrial and business sectors, growth in the population, spread of the education and increase in the purchasing power of the masses. For this reason in most of the studies which we refer below[1] the variables such as gross national product, disposable personal income, Federal Reserve Board's index of industrial production and the size of the population have been used in the estimates of the demand functions for paper and paperboard there. The report prepared by the Presidents' Material Policy Commission (1952) and the U.S. Department of Agriculture (1955) have primarily established a relationship between the gross national product and demand for paper and paperboard, while the U.S. Department of Commerce (1957) and the Stanford Research Institute (1954) based their projections on a more elaborate and detailed analysis of the industry. They have used mainly the aggregate variables rather than percapitas in the estimates of the demand functions for different categories of paper and paperboard.

Unlike the UN/FAO studies, a logarithmic linear function has been used in most of the American studies on demand for paper and paperboard. This implies the assumption of the constant elasticity of demand for paper and paperboard in the United States.

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1. U.S. Department of Commerce (1957); U.S. Department of Agriculture (1955); Stanford Research Institute (1954); U.S.A. President's Material Policy Commission (1952).

(iii) European Studies:

The FAO has undertaken studies on the demand prospect for paper and paperboard in the European region also (UN/FAO 1960,1964). In those studies the demand functions have been estimated in the log-normal form. In addition to the studies of the FAO, three more are worthy of being quoted here. The first one has been conducted by the OECD (1962) for its European member countries. The second and the third studies have been conducted by Sundelin (1964) and Carl Johan Aberg (1968) respectively. In all these studies a relationship has been established between the percapita consumption of paper and paperboard and the percapita income for each country in the region. The study conducted by Sundelin assumed a log-normal relationship between the two variables but Aberg assumed a simple logarithmic relationship. Both of them have paid considerable attention to the analysis of the residuals around the estimated correlation.

(iv) Indian Studies:

In India, demand forecasting models for paper and paperboard have been developed mainly by the Perspective Planning Division of the Indian Planning Commission (1964) and the National Council of Applied Economic Research (1965). The Perspective Planning Division took interindustry approach in the demand forecasting. The interindustry technique of

of demand forecasting is well known by the name of the Input-Output analysis. Its validity depends on the correct estimates of the final demand components. The components of final demand are household consumption, government consumption, investment export and import. The method used to estimate these components of final demand for paper and paperboard has been described fully in the P.P.D's publication "Draft Fourth Plan Material and Financial Balances..." In this report the estimates of the private consumption of different commodities are based on their income elasticities of demand. These income elasticities of demand for various commodities have been calculated using the National Sample Survey (10th Round) data on household expenditure. In this survey only 42 selected commodities have been included. The item 'paper and paperboard' has not been included in this list. So the projection of demand for paper and paperboard by the Planning Commission appears to be crude in the absence of proper data. However, by fitting the demand functions for different categories of paper and paperboard, we may be able to check the estimate of the Planning Commission.

The National Council of Applied Economic Research has estimated the demand functions for paper and paperboard using linear regression method. The demand for different varieties of paper and paperboard has been assumed to be a

function of the school going pupil (X_1), the index of industrial production (X_2), time (X_3) and the national income (X_4). The general model has been postulated as:

$$q_d = a + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4$$

Where q_d is the quantity of paper and paperboard consumed. The final demand equations developed by the NCAER are as follows:

1. Printing and writing paper:

$$q_d = -57.721 + 1.004 X_1$$

2. Newsprint:

$$q_d = -127.328 + 0.928 X_1$$

3. Wrapping Paper:

$$q_d = -161.397 + 6.402 X_2$$

4. Special varieties:

$$q_d = -139.434 + 18.580 X_4$$

5. Paperboard:

$$q_d = 131.252 + 3.464 X_2$$

The approach followed by the NCAER in estimation of the above demand equations cannot be regarded as satisfactory. Objections can be raised against the selection of the explanatory variables as well as against the fomr of

the functions. First the demand for printing and writing paper should not be considered solely as a function of the school going pupils. A large part of the printing and writing paper is used in business and industrial sectors for the communication, record and general administration. A measure of the business and industrial activities must be included as an explanatory variable for the demand of printing and writing papers. Non-farm national income is the best measure for the business and industrial activities. Similar argument holds true for the demand of newsprint also. For the remaining three categories of paper and paperboard i.e. wrapping papers, other varieties and paperboard, the 'non-farm national income' is a better explanatory variable than the index of industrial production or the national income.

The demand functions fitted by the NCAER for different categories of paper and paperboard are linear in shape. They show constant marginal propensity of demand with respect to the explanatory variables taken into account. This result is very much doubtful since by nature, as we have argued earlier, the demand for most of the varieties of paper and paperboard displays constant elasticity and not marginal propensity, with respect to the explanatory variables such as income, number of students and volume of sales, etc. This implies the logarithmic shape of the demand

functions for paper and paperboard which the NCAER overlooked in its study.

Beside the studies discussed above, an important study on the pulp and paper prospects in India has been conducted by the Economic and Scientific Research Foundation New Delhi (1969). In this study percapita income has been taken as the only explanatory variable for estimating the demand functions for different categories of paper and paperboard in percapita terms. These demand functions have been fitted in logarithmic form. This implies the assumption of the constant income elasticity of demand for all categories of paper and paperboard in India.

In the above survey of the studies on demand for paper and paperboard in different parts of the world, we have been mainly concerned with the approaches followed for fitting the demand functions for different categories of paper and paperboard. It was rather necessary to familiarise ourselves with these approaches in order to understand the general nature of the demand function for each category of paper and paperboard. In most of the studies logarithmic demand functions have been investigated for different categories of paper and paperboard but the FAO's studies have shown the exponential fits equally valid especially with the cross-sectional data.

4.4.3 Empirical Analysis:

In the foregoing analysis, we have mainly gone through the specification of the demand functions for different categories of paper and paperboard in India. The demand models that we have finally specified are as follows:

1. Newsprint : $D = f(Y_1, S, Pt, u)$
2. Other Printing & Writing papers;

$$D = f(Y_1, S, P, t, u)$$

3. Wrapping and other papers;

$$D = f(Y_2, P, t, u)$$

4. Paperboard: $D = f(Y_2, P, t, u)$
5. Total paper and paperboard;

$$D = f(Y_1, S, P, t, u)$$

Where: D is the quantity, consumed;

Y_1 is the national income or its trend value,

Y_2 is the nonfarm national income,

S is the total number of students in the country,

P is the price index,

t is the time trend

and u is a random error term.

We will now proceed with the empirical estimates of all these models using the time-series data covering the

period 1950-51 to 1964-65.

(i) Data and Form of Functions:

The information regarding the data to be used in this analysis is given in Chapter 2. We will not repeat it here in this section. Simultaneously we will use the two consumption series for each category of paper and paperboard (except newsprint) in fitting the demand functions. These series are: 'CMI: ASI-Series' and 'MSPS-Series'. All variables except otherwise stated will be taken in index form with the beginning year (1950-51) as base.

The demand function for a particular category of paper and paperboard may be linear or nonlinear. On apriori grounds we do not specify any thing regarding the form of the demand function and leave it to be determined empirically. We will, therefore, estimate both linear and nonlinear versions of the demand function for each category of the paper and paperboard. Among nonlinear relationships, we will only estimate the two types of relationships: logarithmic and exponential. Other types (Ref: Wold and Jurin 1952,pp 3-4) have been ruled out seeing the nature of the demand for paper and paperboard as discussed earlier (Pages 169-175). Moreover, from the previous studies on demand for apaper and paperboard, we do not have any evidence in favour of a nonlinear demand function other than logarithmic

and exponential ones.

(ii) Some Preliminary Results:

Single equation least-squares technique has been used to fit all the demand functions both, linear and non-linear, for the different categories of paper and paperboard. The technique is not only simple to follow, but also gives better estimates than any other technique known so far provided the assumptions underlying it are fulfilled. An important assumption of the least-squares technique is that the explanatory variables in the relationship which is to be fitted by it must be mutually independent. If they are not the estimate of the relationship may not be reliable because of the multicollinearity among them. The demand functions that we intend to fit using the least-squares technique for the different categories of paper and paperboard are to be derived from the variables in terms of historical time series. In this case the inter-correlation among the explanatory variables is natural because of their common trend. By fitting the trend of all the variables involved in the demand functions, we have found a high degree of correlation (0.986) between the income variable (y) and the time trend(t) and similarly, the degree of correlation between the number of students (s) and the trend factor (t) has been found to be of the order of 0.980. On the other hand, the degrees of correlation between the trend

factor (t) and the consumption variables have been found around 0.98 or even less than this. Thus, the apparent multicollinearity between the explanatory variables of the demand functions for paper and paperboard forced us to drop the trend factor (t) from the estimates. Excluding the trend factor (t) from the list of the explanatory variables, preliminary estimates of the demand function for the different categories of paper and paperboard were obtained which are given in Appendix 4.2 of this chapter. From these fitted demand functions we have got the following important results.

1. Price variables were found insignificant in the demand functions for all the categories of paper and paperboard except newsprint for which we have used the 'import prices' rather than the domestic prices, because more than 80% of newsprint requirement during the period under review was met with imports. The domestic price of newsprint therefore, is nothing but but the import price plus custom duties. This gives us the empirical evidence about the prices being ineffective in determining the demand for paper and paperboard in India. This is in agreement with out theoretical expectation mentioned earlier in this chapter.

2. The 'number of the students(S)' has also been found insignificant in most of the fits possibly because of its being highly correlated with the national income.

The degree of correlation between these two variables has been found to be of the order of 0.988 and between the 'nonfarm national income' and the number of students it was 0.996. Such a high degree of correlation between the explanatory variables would naturally cause the multi-collinearity error in the estimation of the demand functions. The problem is now to see whether the correlation between these explanatory variables was due to their trend or really they have a tendency to be highly correlated. In the alternative sets of the regression fits we took all the variables in terms of their first differences. By doing so we have tried to reduce the effect of the trend from the regression estimates of the demand functions but the explanatory variables have still been found correlated together. The degree of their correlation dropped only from about 0.98 to near 0.75. In a country like ours, education mainly depends upon the income. So the correlation between the total number of students and the national income seems to be genuine and with this, the insignificance of the number of students in the demand functions for paper and paperboard may be considered justified.

3. The exponential fits of the demand functions for all five categories of paper and paperboard were not better in any sense than the logarithmic or linear fits. We have, therefore, discarded them and concentrated on the

logarithmic and linear fits in the further refinement of the demand functions.

In the next round of estimation, we have dropped the number of students (S) and the price variables (except for newsprint) from the demand functions and fitted them using the national income or its variant as the sole explanatory variable. The new set of the fitted demand functions for each category of paper and paperboard are as follows:

(iii) <u>Final Results</u>:

(1) <u>Newsprint:</u>

Variables: y_1: National Income at constant Prices.
y_1: Trend value of the National Income.
P: Import Price Index for newsprint.
D: Quantity of newsprint consumed.

All variables are in index form with the beginning year (1950-51) as base.

Regression Equations:

$$(1)\ D = 2.84893 + \underset{(8.44)}{1.35909\, y_1} - \underset{(-2.35)}{0.51333\, P}$$

$R = 0.95302$; $F = 59.39$; $d = 1.56$;

$$(2)\ \ln D = 1.26756 + \underset{(8.07)}{1.44320 \ln y_1} - \underset{(-3.215)}{0.74222 \ln P}$$

$R = 0.95304$; $F = 59.427$; $d = 1.78$;

(3) $D = -80.30347 + 1.53022\ y_1$
$$(9.16)$$
$R = 0.93055;\quad F = 83.954;\quad d = 1.65;$

(4) $\ln D = -3.45528 + 1.68689 \ln y_1$
$$(7.95)$$
$R = 0.91065;\ F = 63.152;\quad d = 1.78$

(5) $D = 9.79210 + 1.37730\ \bar{y_1} - 0.59075\ P$
$$(9.15) \qquad (-2.966)$$
$R = 0.95936;\ F = 69.354;\quad d = 1.54;$

(6) $\ln D = 1.66735 + 1.4483 \ln \bar{y_1} - 0.83122 \ln P$
$$(9.06) \qquad (-4.65)$$
$R = 0.96168;\ F = 73.818;\quad d = 1.63$

(7) $D = -84.26592 + 1.56167\ \bar{y_1}$
$$(9.01$$
$R = 0.9283;\quad F = 81.186;\quad d = 1.35$

(8) $\ln D = -3.48989 + 1.69410 \ln \bar{y_1}$
$$(7.73)$$
$R = 0.90626;\ F = 59.75;\quad d = 1.50$

At 1% level of significance the F value for each of these regression fits is greater than the minimum level of 6.93 with (2,12) degrees of freedom or 9.33 with (1.13) degrees of freedom. It means that the relationships expressed

by these regression fits are highly significant. Further the regression coefficients for both the explanatory variables y_1 and $\bar{y_1}$ are significant as shown by the t-values (shown in brackets) for them which are greater than the minimum limit of 2.97 at 1% level of significance. National income has comparatively higher values of t in all four regression fits than the price. Its significance as a demand factor for newsprint is, therefore, greater than that of the price.

In four equations (Nos. 3,4,7 & 8) we have used the national income or trend value of it as the only explanatory variable. The coefficient of multiple correlation given by these four equations varies between 0.9063 and 0.9305. In the remaining four equations (Nos. 1,2,5,6) in which 'price' has been included as an additional explanatory variable, values of R vary between 0.9530 and 0.9617.. All equations are free from the autocorrelation bias since d or $(4-d) > d_u$ at 2% level of significance with 15 observations. Seeing the values of R and F, equations (1),(2),(5), and (6) in which 'price' is taken as an additional explanatory variable are better fits than equations (3),(4),(7) and (8) where national income is the sole explanatory variable. These equations are, therefore, to be preferred as best estimates of the demand function for newsprint in this scountry.

In fitting the equations (1) and (2), we have taken

the current deflated national income as one of the two explanatory variables, but in fitting the equations (5) and (6), the current national income is replaced by its trend value. Judged on the basis of the multiple correlation coefficient (R) and the F ratio, the trend value of the national income gives slightly better fits than the current value of it. Moreover, in both the cases logarithmic and linear fits give almost identical values of R and F, so from this we cannot say anything definitely regarding the shape of the demand function for newsprint in this country. In view of the nature of demand for the cultural paper of which newsprint is a part, we have argued earlier (Ref: Page 169-79) in favour of constant elasticity demand functions. To support this contention we may accept the log fits (Eqs. (2) and (6)) which give us the following elasticity coefficients.

	Equation (2) (With National Income)	Equation (6) (With "Permanent" National Income)
Income Elasticity Coeff.	1.4432	1.4483
Import Price Elasticity Coeff.	-0.74222	-0.83122

However, unless we go for some other test to establish the shape of the demand function for newsprint in India, the logarithmic shape of it cannot be taken for granted. Linear fits are equally good and there is no reason to reject them.

Analysis of Residuals:

The residulas left 'unexplained' by the four equations (Nos. 1,2,5 & 6) which we accept as the best alternative estimates of the demand function for newsprint in India are shown in Table 4.4. From the table we find that they are more or less random and small in magnitude (below 5% of actual consumption) except for a few years. Their pattern is similar for all the four equations but, there are some minor differences in their magnitude. The residuals obtained from equations (5) and (6) are comparatively smaller in magnitude than those obtained from equations (1) and (2).. This implies that in comparison with the national income, its trend value is a better explanatory variable for the demand of newsprint in India. Both, linear as well as nonlinear fits, have almost similar residuals. Both the types of fits are thus equally valid as the demand function of newsprint in India.

The negative residuals obtained from the fits under examination show overestimation of demand for newsprint and the positive residuals show its underestimation. Nothing can be said precisely regarding the sources of variation in the demand for newsprint in India beside the two explanatory variables that we have incorporated in the regression fits. Prior to 1955, there were no restrictions on use of newsprint. A substantial quantity of newsprint was

being used for purposes other than newspaper publication such as for printing cheap religious books, almanacs, hand bills, etc. and for making exercise books. All this was because of the liberal imports of newsprint at cheap prices. The newsprint imported from Japan was cheaper than old newspapers, so it was used even for wrapping purposes (Rao, 1958, p. 182). Since April,1955 the consumption of imported newsprint was restricted for publication of newspapers and periodicals. The foreign exchange crisis during the Second Five Year Plan period led to new restrictions on newspaper imports, so the Govt. of India adopted a policy of 'fair distribution' of newsprint which continues even today. Thus, the consumption series used in fitting the demand functions shown above do not express the uniformity in consumption of newsprint in India during the period under review (1950-65). The non-uniformity of the consumption series itself is a source for the residuals. For 1961-62 we get considerably high magnitude of the residual (25%). The Third General Election might have been one of the factors for high consumption of newsprint during this year. On the whole the regression fits (Eqs. (1),(2),(5), & (6)) with national,income or its trend value and the 'price' of newsprint as explanatory variables, explain more than 90% (R^2) variation in the consumption of newsprint in India during the period under study.

Table 4.4

Actual & Estimated Consumption of Newsprint in India
1950-51 to 1964-65

(Index: 1950-51 Actual Consumption = 100)

Year	Actual Consumption of News Print Index	Estimated Consumption by				Residual Left unexplained by			
		Eq.1 Linear	Eq.2 Log	Eq.5 linear	Eq.6 Log	Eq.1 Linear	Eq.2 Log	Eq.5 Linear	Eq.6 Log
1950-51	100.00	87.43	89.60	82.72	90.20	12.57	10.40	17.28	9.80
1951-52	65.70	60.12	65.60	77.00	64.07	5.58	0.10	-11.30	0.63
1952-53	70.90	81.20	81.05	83.28	80.30	-10.30	-10.15	-12.38	-9.40
1953-54	93.20	102.16	102.40	93.07	100.00	-8.64	-9.21	0.13	-6.80
1954-55	103.70	102.92	101.90	97.51	100.50	0.78	1.80	6.19	3.20
1955-56	103.00	98.93	96.16	100.87	97.00	4.07	6.64	2.13	6.00
1956-57	100.30	109.62	106.50	109.90	104.25	-9.32	-6.20	-9.60	-3.95
1957-58	102.40	106.50	103.13	108.06	108.30	-4.10	-0.73	-5.67	-5.90
1958-59	104.20	116.23	111.27	121.07	111.40	-12.80	-7.07	-17.37	-7.20
1959-60	126.70	118.38	113.30	123.06	117.90	7.61	13.40	2.94	8.80
1960-61	129.00	138.74	135.64	139.74	133.60	-10.14	-6.64	-11.14	-4.60
1961-62	162.90	141.85	137.07	145.55	137.00	21.05	25.83	17.34	25.90
1962-63	165.10	151.82	152.60	149.84	156.50	13.28	12.50	15.28	8.60
1963-64	165.20	165.04	170.54	161.32	173.54	0.16	-5.34	3.88	-8.34
1964-65	172.31	182.03	190.94	179.99	184.01	-9.73	-18.63	-7.68	-11.71

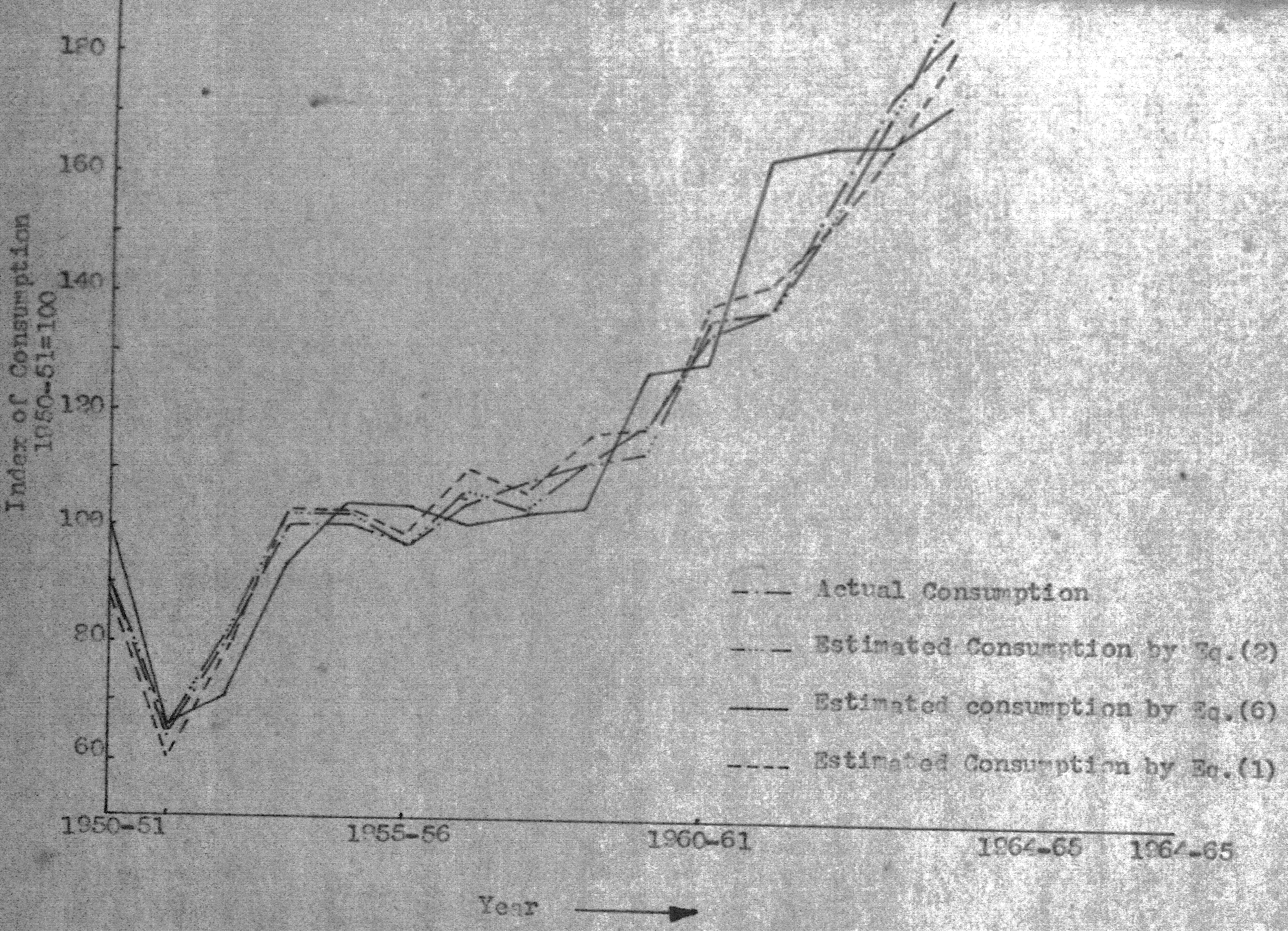


Fig. 4.2
ACTUAL & ESTIMATED CONSUMPTION OF NEWSPRINT

We may recall that the estimates of the demand functions shown above are based on past trends which do not reflect the real demand for newsprint because of a series of constraints. If the supply position had been more comfortable, it would have led to new fits expressing altogether different results regarding the income and price elasticity of demand for newsprint in the country. Such demand functions under free supply conditions will underestimate the demand for newsprint. But it is a matter of opinion whether the supply position of newsprint in the country would improve considerably in the near future or not. Considering the trends in the domestic production of newsprint in the country, we do not envisage any remarkable upward shift in its supply beyond its normal rate of growth (3.7% Ref: Table 4.1). This is evident from the fact that since 1964-65 which is the terminating year of the cosumption series used in fitting the demand functions described above, the production of newsprint in India was almost stationary till the beginning of the Fourth Five Year Plan. It varied between 28.8 to 30.84 thousand tonnes per year. The imports of newsprint during this period varied between 102.5 to 114.5 thousand tonnes per year. As a result average annual growth in the supply and hence in the consumption of newsprint was only about 4000 tonnes as against 7000 tonnes during the period 1959-60 to 1964-65. Thus, seeing the present trends in the supply of newsprint, at least for the coming decade

the demand for newsprint in India may not be free from the supply constraints. Therefore, for this period the empirical validity of the demand functions for newsprint shown above seems to be quite acceptable.

2. Printing and Writing Papers (Excluding Newsprint):

Variables: y_1, National Income at Constant Price (1948-49).

$\bar{y}_1$, Trend Value of the National Income

D , Quantity of Printing & Writing Paper consumed.

All variables are in Index form, 1950-51 = 100.

CMI: ASI Series:

$$(1)\quad D = -456.10461 + 5.37445\, y_1$$
$$(17.73)$$

$$R = 0.97994;\ F = 314.38;\quad d = 1.37;$$

$$(2)\quad \ln(D) = -8.8443 + 2.93073\, \ln(y_1)$$
$$(22.72)$$

$$R = 0.98764;\ F = 516.25;\quad d = 2.17;$$

$$(3)\quad D = -490.28194 + 5.62450\, \bar{y}_1$$
$$(15.66)$$

$$R = 0.97642;\ F = 245.46;\quad d = 0.65^{*}$$

(4) $\ln(D) = -8.93368 + 2.94955 \ln(\bar{y}_1)$

$$(27.356)$$

$R = 0.99208$; $F = 748.369$; $d = 1.50$

M.S.P.S. Series:

(1) $D = -351.8364 + 4.40533\, y_1$

$$(22.17)$$

$R = 0.98703$; $F = 491.309$; $d = 1.30$;

(2) $\ln(D) = -7.42773 + 2.62408 \ln(y_1)$

$$(29.08)$$

$R = 0.99240$; $F = 845.711$; $d = 2.32$;

(3) $D = -359.42048 + 4.46514\, \bar{y}_1$

$$(17.73)$$

$R = 0.97996$; $F = 314.65$; $d = 0.65^{*}$;

(4) $\ln(d) = -7.51999 + 2.64309 \ln(\bar{y}_1)$

$$(28.59)$$

$R = 0.99215$; $F = 817.79$; $d = 1.30$;

Note: * shows autocorrelation.

At 1% level of significance all of these fits are highly significant as shown by their F-ratios which are much greater than the minimum significant gvalue of 9.7 with (1,13) degrees of freedom. The national income (y_1) and its trend value ($\bar{y}_1$) are significant explanatory variables as shown by the t-ratios (shown in brackets) for their

coefficients which are much greater than the minimum significant level of 2.9 at 1% level with 14 degrees of freedom. All fits have a high degree of correlation (R) varying between 0.980 and 0.992. Equations 1,2 and 4 of either series (CMI: ASI & NSPS) are free from the auto-correlation bias (d or $(4-d) > d_u$ at 2% level of significanee with 15 observations) but eq. (3) shows a low degree of autocorrelation among its residuals ($d < d_1 = 0.8$ at 2% with 15 observations).

On the basis of the values of R and F, all logarithmic fits are better than the corresponding linear fits. We accept them as the best alternative estimates of the demand function for printing and writing papers in India. However, the difference in the values of R obtained from the logarithmic and linear fits is very small. Therefore, we do not rule out completely the possibility of printing and writing papers possessing a linear demand relationship. For each of the two consumption series we have two alternative estimates of the demand function-eqations (2) and (4). Eq.(2) is fitted with the national income (y_1) as the explanatory variable while eq.(4) is fitted with the trend value of the national income ($\bar{y}_1$) as the explanatory variable. Both have given almost similar results, but the later one (eq.4) may be preferred it has slightly higher values of R and F than eq.(2).

As mentioned in the beginning of this chapter, the C.M.I: ASI consumption series is better than the MSPS series because it takes into account the full production of paper and paperboard in India. The eqs. (2) and (4) fitted with the CMI: ASI consumption data are, therefore, the best acceptable estimates of the demand function for the printing and writing papers in India. From them the income elasticity of demand for printing and writing papers in India is of the order of 2.93 and 2.95 respectively. Since the national income has been taken as the sole explanatory variable in these demand functions, its pronounced dependence on trend means that all other trend effects on demand for printing and writing papers have been taken into account. Consequently the income elasticity coefficients shown by the demand functions may be distorted upward.

Table 4.5

Income Elasticity of Demand for Printing and Writing Papers

Printing & Writing Paper (Consumption series)	Elasticity with respect to	
	National Income	'Permanent National Income' (i.e. Trend Value of NI)
	Obtained from Eq(2)	Obtained from Eq(4)
CMI: ASI Series	2.93	2.95
MSPS Series	2.62	2.64

Analysis of the Residuals:

The adequacy of the national income or its trend value as the sole explanatory variable for the demand analysis of printing and writing papers in India can be judged from the residuals in the demand that have been left unexplained by them. Using Eq.(2) and Eq.(4) in either case, the estimated CMI:ASI and MSPS consumption series, for printing and writing papers are given in Table 4.6. The table also contains the residuals that have been left unexplained by these two set of equations in either case. Similar estimates of the consumption and residuals for both, the CMI:ASI and MSPS consumption series obtained from Eq.(1) and Eq.(3), are given in Table 4.7. As seen from the tables, there are positive as well as negative residuals for both the consumption series. The residuals are highly uneven in size. In relative term they are mostly around 5% of the actual consumption level but for a few years they are around 10%. The residuals obtained from the Eq.(4) are smaller in magnitudes (except for two years in the MSPS Series) than the residuals given by the Eq.(2). The trend value of the national income ($\bar{y}_1$) thus seems to better explanatory variable for the demand function of printing and writing papers in India than the current national income (y_1). However, the difference between these two set of residuals for both, the CMI:ASI and MSPS consumption series, is not

- contd on page 206.

Table 4.6

Actual & Estimated Consumption of Printing & Writing Papers in India:

Year	Actual Consumption	Estimated Consumption Using Eq.2	Estimated Consumption Using Eq.4	Residuals Left unexplained by Eq.2	Residuals Left unexplained by Eq.4
1	2	3	4	5	6
CMI:ASI Series					
1950-51	100.00	104.90	104.50	-4.90	-4.50
1951-52	117.60	113.75	114.35	3.95	3.25
1952-53	143.30	128.20	127.23	15.10	15.05
1953-54	140.30	151.11	141.45	-10.81	-1.45
1954-55	143.60	162.72	157.18	-19.12	-13.58
1955-56	175.30	171.92	175.00	3.38	0.00
1956-57	187.80	198.25	193.50	-10.45	-5.70
1957-58	205.10	202.67	215.10	2.43	-10.00
1958-59	235.30	234.39	238.65	0.91	-3.35
1959-60	265.60	241.25	265.60	23.35	0.00
1960-61	292.10	304.00	294.70	-11.90	-2.60
1961-62	306.40	328.00	327.70	-21.60	-21.30
1962-63	361.00	346.50	363.90	14.50	-2.90
1963-64	443.40	399.80	403.40	43.60	40.00
1964-65	464.30	497.70	445.85	-33.40	18.45

contd...

(Table 4.6 contd.)

1	2	3	4	5	6
MSPS Series:					
1950-51	100.00	105.20	103.40	-5.20	-3.40
1951-52	115.80	113.18	113.50	1.62	2.30
1952-53	136.70	125.50	125.00	11.20	11.70
1953-54	142.70	146.00	137.40	-3.30	5.30
1954-55	149.80	156.00	150.90	-6.20	-1.10
1955-56	173.10	164.00	166.33	9.10	6.77
1956-57	169.80	186.27	181.80	-16.47	-12.00
1957-58	179.80	186.63	199.90	-6.83	-20.10
1958-59	211.70	216.40	219.60	-4.70	-7.90
1959-60	232.60	222.10	241.53	10.50	-8.93
1960-61	275.80	270.70	266.40	5.10	9.40
1961-62	289.20	292.10	291.50	-2.90	-2.30
1962-63	312.30	370.25	320.20	5.05	-7.90
1963-64	378.40	348.90	352.10	29.50	26.30
1964-65	398.00	424.10	387.20	-26.10	10.80

(Table 4.7 contd.)

	1	2	3	4	5
MSPS SERIES:					
1950-51	100.00	88.70	84.86	11.30	15.13
1951-52	115.80	101.03	100.93	14.77	14.86
1952-53	136.70	119.09	117.90	17.61	18.80
1953-54	142.70	147.29	135.32	-4.58	7.38
1954-55	149.80	160.06	153.18	-10.26	-3.38
1955-56	173.10	169.75	172.38	3.35	0.72
1956-57	169.80	195.75	190.68	-25.95	-20.88
1957-58	179.80	190.46	210.78	-10.65	-30.98
1958-59	211.70	227.90	231.32	-16.20	-19.62
1959-60	232.60	233.63	253.20	-1.03	-20.60
1960-61	275.80	281.65	275.07	-5.85	0.72
1961-62	289.20	298.39	298.29	-9.19	-9.09
1962-63	312.30	310.72	321.96	1.57	9.66
1963-64	378.40	343.76	346.96	34.63	31.44
1964-65	398.00	397.51	372.86	4.90	25.14

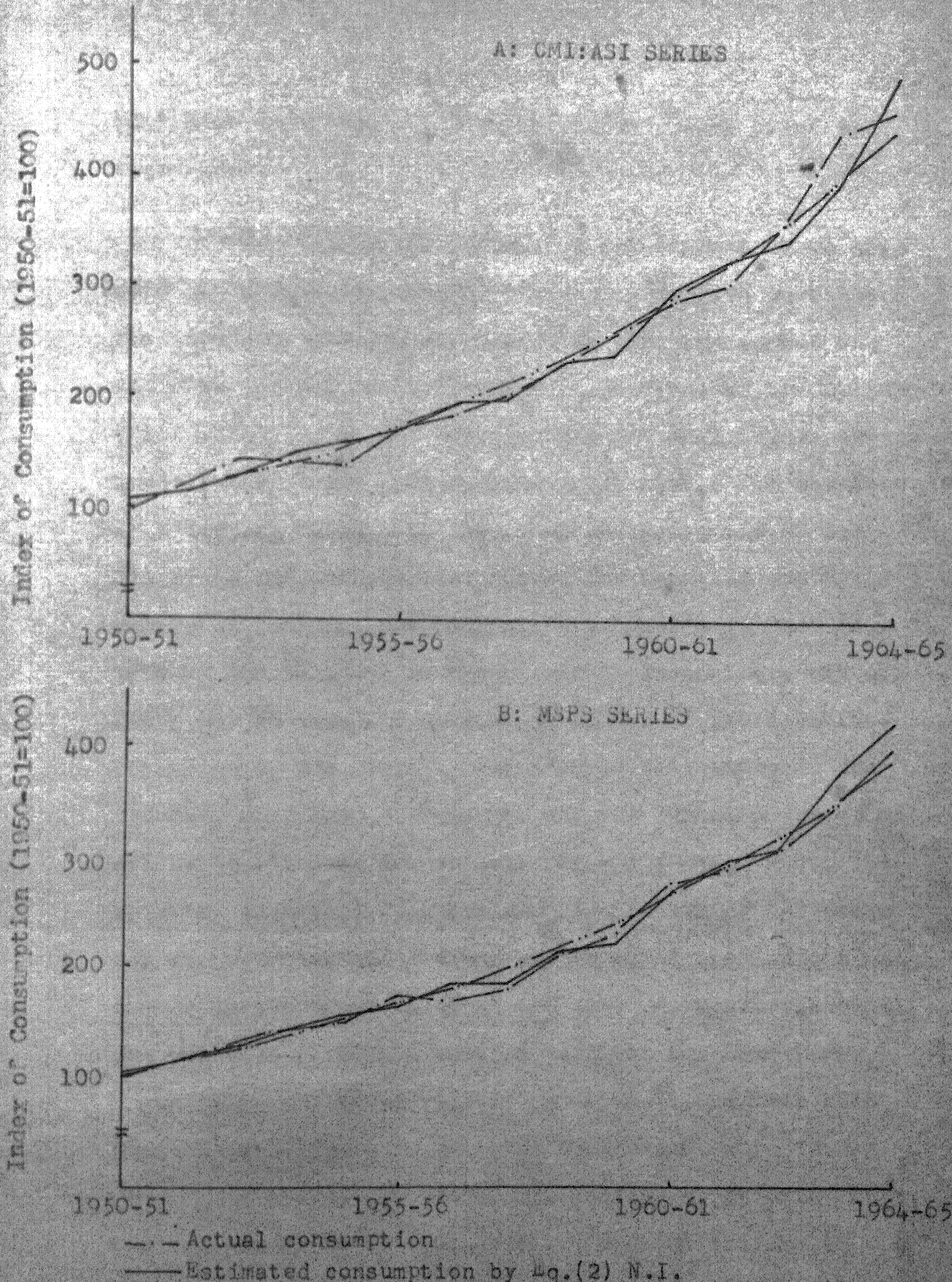


Fig. 4.3

ACTUAL & ESTIMATED CONSUMPTION OF
PRINTING & WRITING PAPERS

very much significant. Both show almost same trend and magnitudes.

In fitting the regression equations that we have used above to calculate the residuals, we have to discard two important explanatory variables viz, the number of students (S) and the time trend (t) because of the multi-collinearity. We have retained the national income or its trend value as the sole explanatory variable for the fits. In doing so, we have assumed that the influence of the discarded variables on the demand for printing and writing papers in India is not 'direct' but 'indirect' that is through the national income. This is an abstract situation. There may be some independent influence of the discarded variables on the demand. For example, variations in the literacy or number of students and the national income may not be in the same proportions for all years. Thus, there is every possibility of the underestimation of the demand for the printing and writing papers using the national income or its trend value as the sole explanatory variable. The positive residuals that we have got for some years, especially, for years 1952-53 and 1963-64, reflect this possibility. For some years we have negative residuals which show overestimation of the demand for printing and writing papers by Eq. (2) or (4). Nonavailability of the printing and writing papers may be one of the reason for

underconsumption during these years.

An important source of the residuals may be the effect of the changes in stocks of the printing and writing papers. Because of the non-availability of data as explained in the beginning of this chapter, we could not take into account the changes in stocks in compilationoof the consumption series that we have used in fitting the demand functions for the printing and writing papers. Hence we are unable to bring out any correlation between residuals and net changes in the stocks of printing and writing papers. Possibility of any such correlation is very low since during the period under review we had shortage of printing and writing papers.

There might be yet another source of the residuals. The series that we have used in estimation of the demand functions may have observational errors. This is of course quite possible. On the whole the residuals are small and highly irregular in size. They are consistent with the assumptions of the least-squares procedure. The fits (Eqs.(2) and (4)) from which we have obtained these residuals are, therefore, reasonably good estimates of the demand functions for printing and writing papers in India. They are capable of explaining more than 92.5% of variation in the actual consumption of the printing and writing papers in India. Both, the national income and its trend value, are

equally good in explaining the demand for the printing and writing papers in India. Any one of them may be accepted for practical purpose.

The use of the trend value of national income as explanatory variable for fitting the demand functions may be debatable. Since it is determined by the time trend (t), it would therefore, be more appropriate to take time trend itself as the explanatory variable for fitting the demand functions for the printing and writing papers. In other words, fitting of the trend for it, would serve the purpose. Following this approach, we have estimated the trend fits for both the alternative consumption series of the printing and writing papers as shown below:

<u>CMI: ASI Series</u>

$$\ln (D) = 4.52259 + 0.10586\ (t)$$
$$(31.38)$$
$$R = 0.99347; \quad F = 984.97; \quad d = 1.33$$

<u>MSPS Series</u>:

$$\ln (D) = 4.54536 + 0.09419\ (t)$$
$$(38.2\ )$$
$$R = 0.99196; \quad F = 798.25; \quad d = 1.61;$$

Both the series exhibit simple exponential trend. We have also found similar trends in the national income.

Thus, both the variables, the consumption of printing and writing papers and the national income, are moving exponentially with time trend, but the relationship among them is logarithmic as we have seen above.

3. Wrapping and Other Miscellaneous Papers:

Nonfarm national income (y_2) has been assumed as the sole explanatory variable for the demand of this category of paper and paperboard in India. The fitted regression equations for both the alternative consumption series are as follows:

CMI:ASI Series

(1) $D = -64.02261 + 2.06021\,(y_2)$
(8.8)

$R = 0.92505;\quad F = 77.1;\quad d = 0.46^{*}$

(2) $\ln(D) = -1.99802 + 1.49690\,\ln(y_2)$
(8.0)

$R = 0.91087;\quad F = 63.3;\quad d = 0.58^{*}$

MSPS Series

(1) $D = -110.35156 + 2.26784\,(y_2)$
(15.7)

$R = 0.97292;\quad F = 230.3;\quad d = 1.16;$

(2) $\ln(D) = -3.03575 + 1.68933\,\ln(y_2)$
(12.71)

$R = 0.96205;\quad F = 161.8\;;\quad d = 0.78^{*}$

At 1% level, all these relationships are significant as shown by their F-ratios which are much greater than the minimum significant level of 9.7 with (1,13) degrees of freedom. The degree of correlation (R) is quite high in all these fits but three of them show the autocorrelation bias among their residuals ($d < (d_L = .81)$ at 1% with (15,1) observations).. Comparing the values of R and F, the linear fits are better than the log fits.. From the superiority of the linear fits we come to the conclusion that the demand for wrapping and other miscellaneous papers in India is a linear function of the nonfarm national income.

The regression fits of the CMI: ASI consumption series are not very much impressive. The residuals obtained from them are quite large (Ref: Table 4.8). For the first four years (1950-51 to 1954-55) the residuals are negative indicating overestimation of the demand, for next 7 years (1955-56 to 1960-61) they are positive indicating underestimation and after that they are again negative. Almost same pattern is seen in the residuals obtained from the fits for the MSPS series but they are smaller in magnitude.

An important source of the residuals, especially for the years 1962-63 to 1964-65 for which we have highly negative residuals, may be the increase in the consumption of the substitutes for the wrapping papers. Plastic films

such as polyethylene and cellophane, are better wrapping materials than paper. They are odourless, colourless and tasteless having considerable strength and tearing resistence. Moreover, they conform well with the shape of the article being packaged. Consumption of these materials for wrapping purpose in India was very low before 1959, but since then, they are being used in increasing volume. Consumption of polyethylene for example, was below 1505 tonnes per year before 1959, but since then it has gone up very rapidly reaching 10911 tonnes in 1964 and 15738 tonnes in 1966 (See Fig. 4.5) and the Planning Commission estimated it to reach 47,220 tonnes in 1970-71. With the development of petro-chemical industries in India during the early sixtees, supply of polyethylene and other plastic products used in packaging has increased remarkably (Shaha, 1967,p 67) In view of their superiority as wrapping materials, relative cheapness and bright prospects of supply in future, they may altogether ousted the wrapping papers from the market. In the demand functions shown above we could not include any variable to take this possibility into account. These fits, therefore, give overestimates of the demand for wrapping papers for the years 1961-62 onwards when the consumption of polyethylene increased rapidly. The gap between the actual and estimated demand for wrapping paper obtained from them may be considered as share of the substitutes

of the wrapping papers.

The nonfarm national income (y_2) used as the explanatory variable in fitting the demand functions shown above, varies strongly with trend. The degree of correlation between it and the time (t) has been found in the order of 0.995. Replacing the nonfarm national income by the calender time (1950-51=1), we have fitted a set of the trend equations for both the consumption series of wrapping and other papers. The best trend fits obtained for them are as follows:

CMI:ASI Series:

(1) $D = 106.40665 + \underset{(15.54)}{14.03750}\ (t)$

$R = 0.97414; \quad F = 241.633; \quad d = 0.87;$

(2) $\ln(D) = 4.54870 + \underset{(18.8)}{0.42502}\ \ln(t)$

$R = 0.98215; \quad F = 354.3; \quad d = 2.09;$

MSPS Series:

(1) $D = 81.38094 + \underset{(25.7)}{14.94572}\ (t)$

$R = 0.991; \quad F = 659.2; \quad d = 1.57$

(2) $\ln(D) = 4.42648 + \underset{(11.10)}{0.44}\ \ln(t)$

$R = 0.951; \quad F = 123.27; \quad d = 1.58$

Comparing these trend fits with the demand functions obtained earlier, we find them better in every respect. They have higher values of R and F and the residuals obtained from them are smaller in magnitudes (Ref: Table 4.8). The CMI: ASI series shows the logarithmic trend but it is linear for the MSPS series. Actually the CMI:ASI series displays two distinct trends, one for the period 1950-51 to 1958-59, and the other for the period 1959-60 onwards when consumption of polyethylene increased rapidly in India. A single trend fit covering both these time intervals as we have done above, is only an approximation. As a matter of fact both the trends should have been fitted separately, but we have not done so because, it was found somewhat less useful for practical purpose. Instead, we have fitted the demand functions covering the period 1950-51 to 1958-59 and 1959-60 onwards separately which are given below:

<u>Additional Demand Functions for 'Wrapping and other Papers': CMI: ASI Series</u>:

(i) For the period 1950-51 to 1958-59 (No. of observations=9)

(a) $D = -300.72141 + 4.08587\, y_2$

$$(13.17)$$

$R = 0.9804;\ F = 173.34;\ d = 2.660$

(b) $\ln D = -8.24163 + 2.81218 \ln y_2$
(10.52)

$R = 0.9698$; $F = 110.77$; $d = 2.465$;

(ii) For the period 1959-60 to 1964-65 (No. of obs = 6):

(a) $D = 112.06952 + 0.99068\, y_2$
(5.31)

$R = 0.9359$; $F = 28.24$; $d = 1.24$

(b) $\ln D = 2.68713 + 0.57438 \ln y_2$
(4.78)

$R = 0.92226$; $F = 22.88$; $d = 1.24$;

On the basis of R, F and T ratios (shown in brackets) all these fits are significant. The linear fit of the demand function for wrapping paper is better than its logarithmic counterpart for both the periods. This supports our previous results of this analysis regarding the shape of the demand function for this category of paper and paperboard in India. Comparing the linear fits, we find considerably low marginal income propensity of demand (Coeff. of y_2) for wrapping and other papers in the country during the period 1959-60 onwards. Increasing use of polyethylene and other plastic products in packaging, as we have mentioned above, was the main factor for low consumption of wrapping papers during this period.

Table 4.8

Actual & Estimated Consumption of Wrapping & Miscellaneous Papers in India

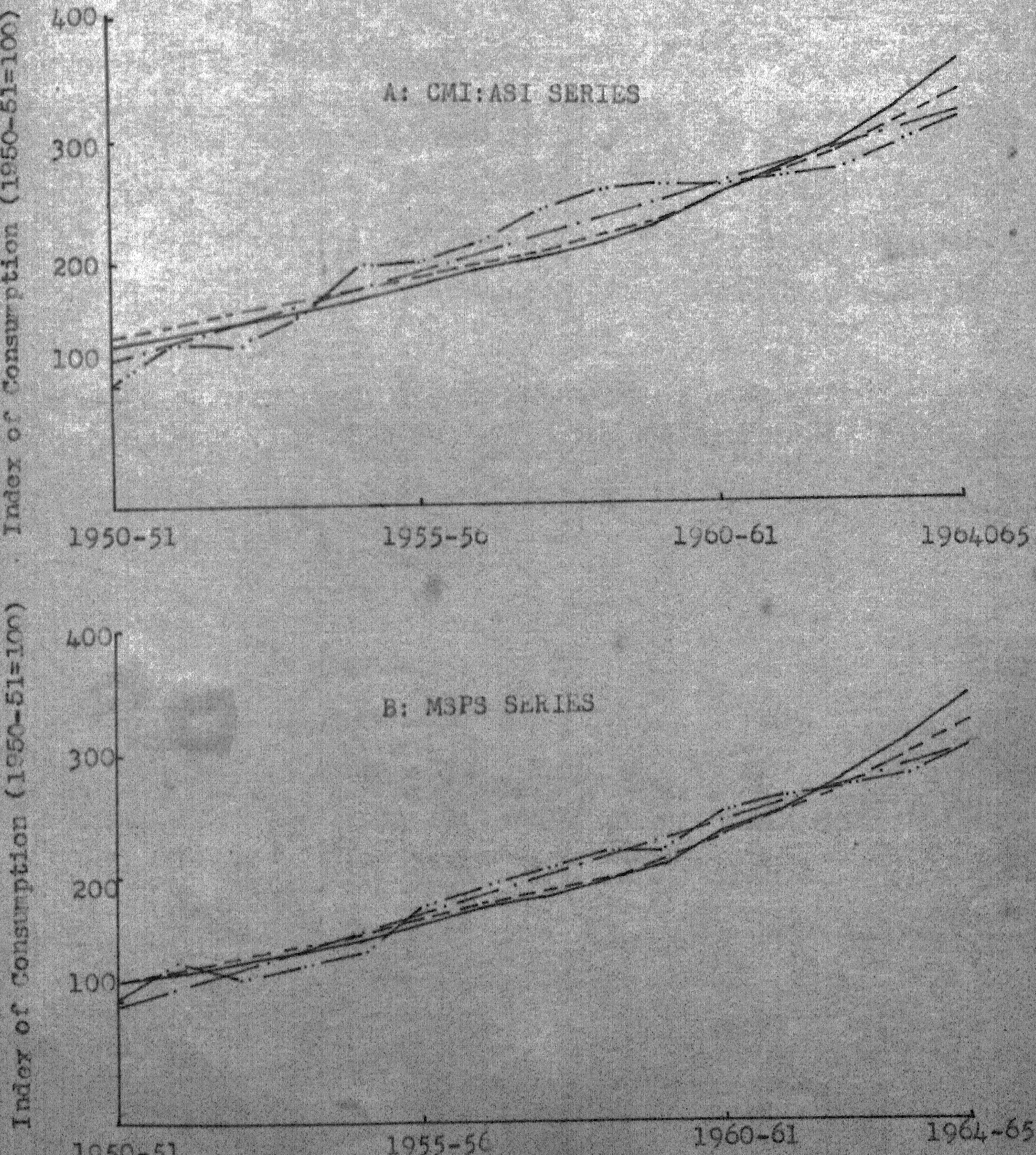
Year	Actual Consumption	Estimated Consumption: Linear* Fit Eq.1	Estimated Consumption: Log Fit Eq.2.	Residuals From: Linear* Fit Eq.1	Residuals From: Log Fit Eq.2
	1	2	3	4	5
CMI:ASI SERIES:					
1950-51	100.0	142.0(120.0)	133.6	-42.0(-20.0)	-33.6
1951-52	137.7	149.8(134.5)	141.3	- 12.1(3.2)	-3.6
1952-53	130.7	159.1(148.4)	150.6	-28.4(-17.8)	-19.9
1953-54	150.7	167.3(162.5)	159.1	-16.6(-11.8)	-8.4
1954-55	193.7	176.6(176.6)	168.5	17.1(17.1)	25.2
1955-56	200.0	186.9(190.6)	179.6	13.1(9.4)	20.4
1956-57	213.3	200.3(204.7)	194.2	13.0(8.6)	19.1
1957-58	237.0	206.1(218.7)	200.3	30.9(18.3)	36.7
1958-59	255.3	216.4(232.7)	212.1	38.9(22.6)	43.2
1959-60	262.3	228.7(246.8)	226.1	33.6(15.5)	36.2
1960-61	260.0	251.4(260.8)	252.9	8.6(-0.8)	7.1
1961-62	265.39	266.4(274.8)	271.3	-1.1(-10.5)	6.0
1962-63	271.30	284.9(288.9)	294.1	-13.6(-17.6)	-22.8
1963-64	293.3	308.9(302.9)	325.1	-15.6(-9.6)	-31.8
1964-65	310.0	335.7(316.9)	360.3	-25.7(-6.9)	-50.3

* Figs. in brackets have been derived from the trend fits.

(Table 4.8 contd.)

	1	2	3	4	5
MSPS SERIES:					
1950-51	100.0	116.4(96.3)	114.9	-16.4(3.7)	-14.9
1951-52	128.9	125.5(111.3)	122.4	3.4(17.6)	6.5
1952-53	116.9	135.3(126.2)	131.5	-18.4(-9.3)	-14.6
1953-54	128.9	144.3(141.2)	139.8	-15.4(-12.3)	-10.9
1954-55	138.2	154.5(156.1)	149.3	-16.3(-17.9)	-11.1
1955-56	175.4	165.9(171.0)	160.3	9.5(4.4)	-15.1
1956-57	192.9	180.6(186.0)	175.0	12.3(6.9)	17.9
1957-58	205.5	187.0(200.0)	181.3	18.5 (4.6)	24.2
1958-59	220.0	198.3(215.8)	193.5	21.7(4.1)	6.5
1959-60	223.4	211.9(230.8)	207.9	11.5(-7.4)	15.5
1960-61	254.2	238.0(245.8)	237.2	16.2(8.4)	17.0
1961-62	265.2	253.4(260.7)	255.2	11.8(4.5)	10.0
1962-63	272.0	273.8(275.7)	279.8	-1.8(-3.7)	-7.8
1963-64	282.5	300.1(290.6)	312.9	-17.6(-8.6)	-30.0
1964-65	310.2	329.6(305.6)	351.8	-19.4(4.6)	-41.6

* Figs. in brackets have been derived from the trend fits.



—··— Actual consumption
---- Estimated consumption by linear fit
—— Estimated consumption by log fit
—·— Estimated consumption by trend fit

Fig. 4.4

ACTUAL & ESTIMATED CONSUMPTION OF WRAPPING & MISCELLANEOUS PAPERS

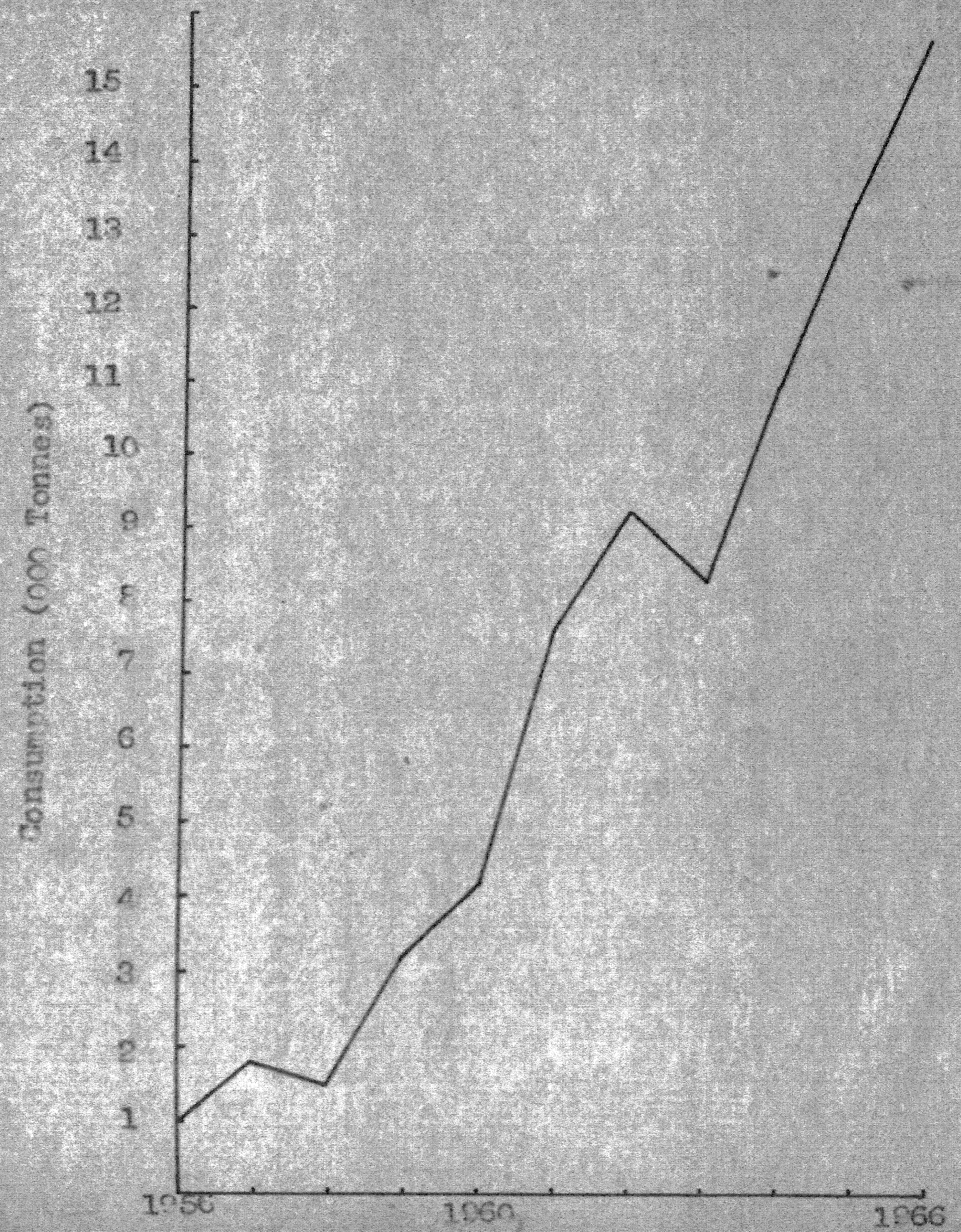


Fig.4.5

Consumption of Polyethylene

1956	1000	Tonne
1957	1794	"
1958	1505	"
1959	3228	"
1960	4227	"
1961	7640	"
1962	9269	"
1963	8324	"
1964	10911	"
1965	13534	"
1966	15738	"

Source: Shaha, S.M., 'Whither Plastic Industry'. Indian Chemical Journal Vol.11, No.5, Nov. 1967, p.67.

4 Paperboard:

Using the nonfarm income (y_2) as sole explanatory variable the demand functions fitted for the paperboard are as follows:

CMI:ASI Series:

$$(1) \quad D = -225.45589 + 3.34344\, y_2$$
$$(14.3)$$
$$R = 0.96956; \quad F = 203.8; \quad d = 0.95$$

$$(2) \quad \ln(D) = -5.31512 + 2.17726\, \ln(y_2)$$
$$(12.60)$$
$$R = 0.96142; \quad F = 158.8; \quad d = 0.60^{*}$$

MSPS Series:

$$(1) \quad D = -200.54667 + 2.97858\, (y_2)$$
$$(18.75)$$
$$R = 0.98201; \quad F = 351.5; \quad d = 1.48$$

$$(2) \quad \ln(D) = -5.07706 + 2.10662\, \ln(y_2)$$
$$(13.91)$$
$$R = 0.96799; \quad F = 193.4; \quad d = 1.185;$$

Where y_2 is the nonfarm national income.

D is the quantity of paperboard consumed.

Both the variables are in index form (1950-51=100).

Note: *Shows autocorrelation

All these four regression fits are significant at 1% level ($F > F_{(0.01)} = 9.7$ with (1,13) degrees of freedom). As shown by the values of R,F and 'd' linear fits are better than the log fits. From the superiority of the linear fits we have reached the conclusion that the demand for paperboards in India is a linear function of the nonfarm income. The regression residuals obtained from the linear as well as the logarithmic fits for both the consumption series of paperboard are shown in Table 4.9. As seen from the table the residuals obtained from the linear fits are smaller in size for most of the years than those obtained from the log fits. Both the fits have, however, given negative residuals for the beginning and ending years of the two series but for the middle range of the series the residuals are positive. For the years 1958-59 and 1959-60 the residuals are considerably high indicating underestimation of the demand for paperboards. During these years prices of paper and paperboard have increased remarkably which forced the Government of India to control them in the following year. Rising prices should have reduced the demand for paper and paperboard but actually it was not found so. It might have induced the manufacturers to produce more and since we have disregarded the inventories, more production means more consumption. With the inventory correction, the actual consumption of paperboard during these years might have been lower as revealed by

the fitted regression equations.

Beside the nonfarm national income some other factors such as the 'number of students' might have influenced the demand for paperboard in India during the years under study. This is quite possible as a large quantity of paperboard is consumed in schools and colleges for educational purposes. The nonfarm income with which the number of students has been found closely correlated ($r = 0.995$) might have not taken this part of paperboard consumption fully into account, leaving high positive residuals. On the other hand shortage of the paperboard supply might have been caused the underconsumption of the paperboard during the years for which we have got the negative residuals. On the whole the nonfarm income could be able to explain about 95% variation in the consumption of paperboard in India during the period 1950-65.

Like the category of wrapping papers, the consumption of paperboard in India is varying linearly with time as shown by the following trend fits:

<u>CMI: ASI Series</u>:

$$D = 57.62952 + \underset{(20.2)}{21.98214}\ (t)$$

$$R = .985; \quad F = 410.3; \quad d = 1.56;$$

Table 4.9

Actual & Estimated Consumption of Paperboard in India

CMI:ASI SERIES:

Year	Actual Consumption	Estimated Consumption: Linear* Fit Eq.1	Estimated Consumption: Log Fit Eq.2	Residuals: Linear* Fit Eq.1	Residuals: Log fit Eq.2
	1	2	3	4	5
1950-51	100.0	108.9(76.6)	111.3	-8.9(24.4)	-11.3
1951-52	114.0	126.6(101.6)	120.5	-12.6(12.4)	-12.6
1952-53	125.6	136.6(123.6)	132.3	-11.0(2.0)	-11.0
1953-54	123.5	150.0(145.5)	143.2	-26.5(-22.0)	-26.5
1954-55	146.5	165.0(167.5)	156.0	-18.5(-21.0)	- 9.5
1955-56	195.6	181.7(189.5)	170.9	13.9(6.9)	24.9
1956-57	190.2	203.5(211.5)	191.3	-13.3(-21.3)	-1.1
1957-58	213.3	212.9(233.4)	200.5	0.4(-20.1)	12.8
1958-59	280.7	229.6(255.4)	217.7	51.1(25.3)	63.0
1959-60	293.3	249.6(277.4)	238.9	53.7(15.9)	54.4
1960-61	309.8	288.0(299.4)	283.2	21.8(10.4)	26.6
1961-62	326.5	310.8(321.4)	311.0	15.7(5.1)	14.5
1962-63	315.9	340.9(343.4)	350.4	-25.0(-27.5)	-34.5
1963-64	372.1	379.7(365.4)	403.4	-7.6(6.7)	-31.3
1964-65	395.3	423.2(387.3)	468.7	-27.9(8.0)	-73.4

* Figs. in brackets have been estimated using the trend equations.

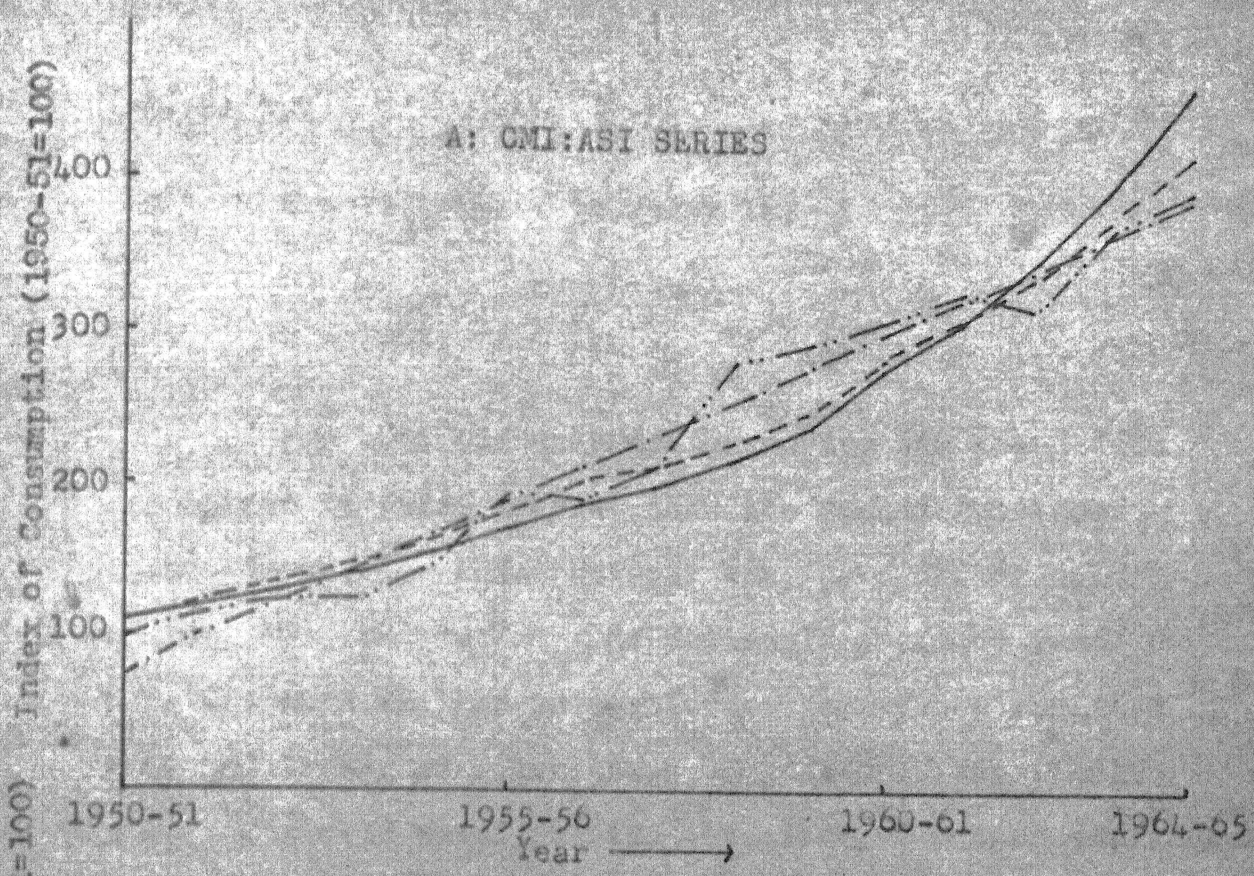
Contd...

(Table 4.9 contd.)

MSPS SERIES:

	1	2	3	4	5
1950-51	100.0	97.3(73.2)	101.9	2.7(26.8)	-1.9
1951.52	110.2	108.6(92.5)	110.2	1.6(16.7)	0.0
1952-53	110.2	122.0(111.8)	120.5	-11.8(-1.6)	-10.3
1953-54	103.4	134.0(131.1)	130.2	-30.6(-27.7)	-26.8
1954-55	136.2	147.4(150.4)	141.3	-11.2(014.2)	-5.1
1955-56	185.1	162.2(169.7)	154.3	22.9(15.4)	30.8
1956-57	174.9	181.6(189.0)	172.3	-6.7(-14.1)	2.6
1957-58	181.7	189.9(208.3)	180.2	-8.2(-26.6)	1.5
1958-59	237.4	204.8(227.6)	194.2	32.6(9.8)	43.2
1959-60	243.8	222.7(246.9)	213.6	21.1(-3.1)	30.2
1960-61	256.6	256.9(266.2)	251.6	-0.3(-9.6)	5.0
1961-62	285.1	277.2(28.5)	275.9	7.9(-0.4)	9.2
1962-63	310.6	304.0(304.7)	309.5	6.6(5.9)	1.1
1963-64	330.4	338.6(324.1)	355.7	-8.3(6.3)	-25.3
1964-65	359.1	377.3(343.4	411.5	-16.2(15.7)	-52.4

* Figs. in brackets have been estimated using the trend equations.



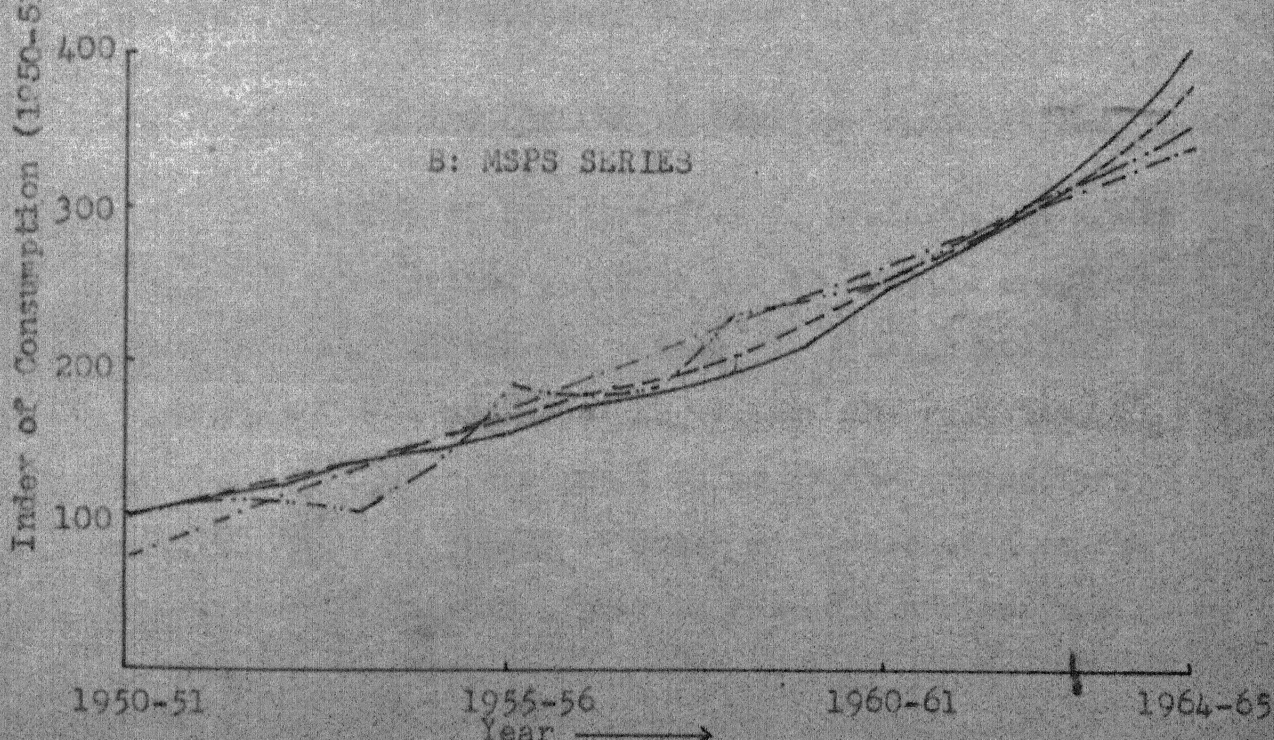


Fig. 4.6

ACTUAL & ESTIMATED CONSUMPTION OF PAPERBOARD

MSP3 Series:

$$D = 53.91141 + 19.29857\ (t)$$
$$(19.2)$$

$R = .983$; $F = 310.2$; $d = 1.13$;

For both the consumption series the trend fits are better in every respect than the demand functions discussed above. Comparatively they have higher values of 'R', 'F', and 'd' and the residuals obtained from them are much smaller in magnitudes than those obtained from the linear or logarithmic demand functions (Table 4.9). The time trend (t) is, therefore, a better explanatory variable for the paperboard consumption in India.

5. Total Paper and Paperboard (Excluding Newsprint):

Because of the diversity in products and their uses, a single demand function for the entire group of paper and paperboards may not be practically useful. However, we have estimated it to test the relevancy of the national income or its trend value as the explanatory variable for the demand of paper and paperboard at the aggregate level. The estimated demand functions are shown as below:

Variables y_1: National Income at Constant Prices
$\bar{y}_1$: Trend Value of the National Income

D : Quantity of Paper and Paperboard Consumed

t : Trend

All the variables except 't' are in index form with 1950-51 as base.

Regression Fits -

CMI:ASI Series:

(1) $D = -374.68920 + 4.70822\ y_1$
(23.88)
$R = 0.98879$; $F = 570.0$; $d = 1.55$;

(2) $\ln(D) = -7.86479 + 2.72806\ \ln(y_1)$
(20.0)
$R = 0.98419$; $F = 401.4$; $d = 1.48$;

(3) $D = -391.54629 + 4.84039\ \bar{y}_1$
(32.7)
$R = 0.99391$; $F = 1067.6$; $d = 0.934$;

(4) $\ln(D) = -8.14169 + 2.78518\ \ln(\bar{y}_1)$
(39.9)
$R = 0.99594$; $F = 1590.3$; $d = 1.75$;

(5) $\ln(D) = 4.57291 + 0.09910(t)$
(39.2)
$R = 0.99580$; $F = 1538.7$; $d = 1.55$

MSPS **Series:**

(1) $D = -312.4334 + 4.05713\ (y_1)$
(29.64)

$R = 0.99269;\quad F = 878.86;\quad d = 1.956;$

(2) $\ln(D) = -7.01242 + 2.53447\ \ln(y_1)$
(26.8)

$R = 0.99112;\quad F = 722.2;\quad d = 1.97;$

(3) $D = -322.54538 + 4.13662\ \bar{y}_1$
(27.80)

$R = 0.99169;\quad F = 772.8;\quad d = 0.965;$

(4) $\ln(D) = -7.17179 + 2.56738\ \ln(\bar{y}_1)$
(44.39)

$R = 0.99672;\quad F = 1970.9;\quad d = 2.54;$

(5) $\ln(D) = 4.5785 + 0.0915(t)$
(43.67)

$R = 0.99662;\quad F = 1907.3;\quad d = 2.53;$

All of these fits are significant at 1% level as shown by their F ratios. Values of the correlation coefficient are high in all equations and they are free from the autocorrelation bias since d or $(4-d) > d_u$ at 1% level of significance except for eq. 3 in either set where $d_L < d < d_u$ showing the neutraility of 'd-Watson'test.

Eq. (5) in both the series shows the exponential trend in growth of the total consumption of paper and paperboard in India. Comparing the values of R and F linear fits are better than the logarithmic fits. This shows that the overall demand for paper and paperboard in India is a linear function of the national income or of its trend value.

(iv) Lag Models:

While discussing the demand factors for paper and paperboard, we have come across the point that fortuitious or unexpected variations in the current income may not affect the demand for paper and paperboard for which the normal or expected income over a long period seems to be a better explanatory variable. In Friedman's terminology as we have mentioned earlier, normal or expected income is called by the name of "permanent income" and the difference between the current and permanent income is called as "transitory income". Permanent income can be expressed in term of a weighted average of current and past income levels. This involves a distributed lag model for it. With the possibility of the permanent national income being a relevant demand factor for paper and paperboard in India, we have estimated a set of distributed lag models which are specified as follows:

(1) $D = f(Y_t, Y_{t-1})$

(2) $D = f(Y_t, Y_{t-1}, Y_{t-2})$

(3) $D = f(Y_t, Y_{t-1}, Y_{t-2}, Y_{t-3})$

(4) $D = f(Y_t, Y_{t-1}, Y_{t-2}, Y_{t-3}, Y_{t-4})$

(5) $D = f(Y_t, Y_{t-1}, Y_{t-2}, Y_{t-3}, Y_{t-4}, Y_{t-5})$

Where D is quantity of paper and paperboard consumed (Index 1950-51 = 100)

Y is National Income (Index Series, 1950-51=100

The regression fits fot all these models have been found quite unsatisfactory from which we could not draw any conclusion. Among them, model (3) however, gave slightly better fits which are as follows:

<u>For Total Paper and Paperboard</u>:

(1) $D = -450.75079 + 0.42950\, y_t - 1.09606 y_{t-1} + 2.70678 y_{t-2} + 3.77399\, y_{t-3}$

(0.41) (-0.82) (2.22) (2.73)

$R = 0.99536$; $F = 187.095$; $d = 1.70$

(2) $\ln(D) = -8.17696 - 0.61216 \ln(y_t) - 0.42356 \ln(y_{t-1})$

(-0.77) (-0.44)

$+ 1.93392 \ln(y_{t-2}) + 1.96547 \ln(y_{t-3})$

(2.17) (2.05)

$R = 0.99084$; $F = 94.23$; $d = 0.99$;

For Printing and Writing Papers:

$$(1)\ \ln(D) = -10.10783 + \underset{(0.887)}{0.51000}\ \ln(y_t) \underset{(-0.5)}{-0.35545}\ \ln(y_{t-1})$$

$$+ \underset{(2.31)}{1.48825}\ \ln(y_{t-2}) + \underset{(2.31)}{1.59902}\ \ln(y_{t-3})$$

$$R = 0.99634; \quad F = 237.547; \quad d = 2.23;$$

At 5% level with 14 degrees of freedom only y_{t-2} and y_{t-3} have somewhat significant coefficients. Thus two and three years lagged values of the national income seem to be relevant for determining the current demand for paper and paperboard. Further, on adding y_{t-4} and y_{t-5} as explanatory variables to these fits the coefficients of y_{t-2} and y_{t-3} turn out to be insignificant. The fits are inconsistent with the reality because, current national income cannot be an insignificant factor in determining the demand for paper and paperboard. Moreover, the fits are not free from the multicollinearity bias as indicated by the high degrees of correlation ($r = 0.975$ to 0.985) among the explanatory variables. Because of this, we have to discard them altogether. Alternatively, we have taken the trend value of the national income as an approximation of the permanent income which gave better fits. These fits together with others have already been discussed earlier.

(v) Estimates of the Demand Functions for Paper and Paperboard With 'Number of Students' Data:

Apart from the national income or its variant the number of students is an important determinant of the demand for printing and writing papers and newsprint. In the regression estimates of the demand functions for these categories of paper and paperboard, however, we could not incorporate this variable explicitly since it was found to be highly correlated with the national income variable resulting in the multicollinarity. To avoid the multicollinearity, it was inevitable for us to take either of the two explantory variables i.e. the national income or the number of students to fit the demand functions for the printing and writing papers and newsprint. We have preferred the national income variable on the plea that in a country like ours education for which the number of students is a quantitative measure, mainly, depends upon the income. If we do not take this view seriously and drop the national income variable instead of the number of students, the resulting fits of the demand functions for paper and paperboard may be equally acceptable at least from statistical point of view. Following this approach, the regression fits of the demand functions for three different categories of paper and paperboard i.e. newsprint, other printing and writing papers and total paper and

paperboard have been estimated by us which are given as follows:

Variables: D = Index of the Quantity of a particular Category of paper & paperboard consumed, (1950-51=100).

S_t = Index of the Number of Students (1950-51 = 100).

P = Index of the Price of Newsprint (1950-51 = 100).

1. Newsprint:

$$(1.1)\quad D = 81.85118 + \underset{(13.91)}{0.59672\, S_t} \underset{(-3.32)}{-0.49219\, P}$$

$$R = 0.974; \quad F = 111.132; \quad d = 1.830;$$

$$(1.2)\quad \ln(D) = 4.16370 + \underset{(13.09)}{0.83734 \ln(S_t)} \underset{(-4.48)}{-0.75924 \ln(P)}$$

$$R = 0.971; \quad F = 99.104; \quad d = 1.699;$$

2. Other Printing and Writing Papers:

$$(2.1)\quad D = -112.86104 + \underset{(24.15)}{2.16539\, S_t};$$

$$R = 0.989; \quad F = 583.36; \quad d = 1.220;$$

(2.2) $\ln(D) = -2.09392 + 1.48025 \ln(S_t)$

(26.89)

$R = 0.991; \quad F = 723.31; \quad d = 1.556$

MSPS Series:

(2.4) $D = -69.03234 + 1.76580\ S_t$

(26.58)

$R = 0.991; \quad F = 706.4; \quad d = 1.46;$

(2.5) $\ln(D) = -1.34760 + 1.31819 \ln(S_t)$

(25.81)

$R = 0.990; \quad F = 666.38; \quad d = 1.360;$

3. Total Paper and Paperboard (Excluding Newsprint):

CMI:ASI Series:

(3.1) $D = -72.47513 + 1.88706\ S_t$

(30.09)

$R = 0.993; \quad F = 905.69; \quad d = 1.175;$

(3.2) $\ln(D) = -1.58220 + 1.37800 \ln(S_t)$

(23.02)

$R = 0.988; \quad F = 530.12; \quad d = 0.847;$

MSPS Series:

(3.4) $D = -51.48997 + 1.62369\ S_t$

$(37.405$

$R = 0.995; \quad F = 1399.16; \quad d = 1.87;$

$$(3.5)\ \ln(D) = -1.16263 + 1.27776 \ln(S_t)$$
$$(30.23)$$
$$R = 0.993; \quad F = 913.85; \quad d = 1.407;$$

Judged on the basis of R,F and t values, all these fits are highly significant at 5% level and as shown by the 'd' statistic, they are free from the autocorrelation bias. Both the types of fits i.e. linear as well as logarithmic give, almost, identical value of R. It is, therefore, difficult to discreminate them. For simplicity the linear fits may be preferred over their logarithmic counterparts. From statistical point of view, no doubt, these fits are highly significant, their practical usefulness may, however, be questioned on the ground that apart from the educational sector, a large quantity of printing and writing papers is consumed in the non-educational sectors such as business and industries for which the number of students is not a relevant explanatory variable. The national income (or its variant) is an appropriate explanatory variable for this as well as for the quantity of paper and paperboard consumed in the educational sector of the country. Therefore, the empirical relevancy of the demand functions for paper and paperboard based on the national income data is greater as compared with the above demand functions which are based on the number of students data.

(VI) Estimates of the Demand Functions for Paper and Paperboard from 'Percentage Deviation Around Trend' Series:

As we have mentioned earlier, the explanatory variables i.e. National Income, Nonfarm National Income and Number of Students' used in fitting the demand functions for different categories of paper and paperboard in this study, exhibit more or less similar trend resulting in high degree of multicollinearity among themselves. Because of this, it was not possible for us to fit the multiple regression equations for the demand functions by incorporating them together. Their first differences i.e. year to year fluctuations which were also found highly correlated among themselves, could not remove the multicollinearity from the regression fits resulting in insignificant coefficients for the national income or nonfarm national income (Ref: Appendix 4.1). The effect of the multicollinearity from the regressio fits can be removed completely by taking all the variables (dependent as well as explanatory) in terms of percent deviations from their trends. Theoretically this is an ideal procedure for establishing meaningful relationships between the variables. In practice, however, it is very difficult to get reliable fits from the fluctuations around trend of the variables unless they are completely free from the measurement errors. This is, because, such deviations are generally supposed to be very much sensitive of the measurement errors in the variables, in presence of which

they may give insignificant or all together a distorted picture of the relationship envisaged. This is evident from the following regression fits of the demand functions for paper and paperboard in which the variables have been taken in terms of percent deviations from their trends. The fits are far from the significance levels as indicated by their F - ratios ($F < F_{0.10} = 2.54$ with (3,11) degrees of freedom) or $F < F_{0.10} = 2.81$ with (2,12) degrees of freedom. The regression coefficients for the variables are also insignificant at 10% level of significance. The coefficients for the nonfarm national income (y) are positive though insignificant in the fits, but for the number of students (s) they are negative in most of them (except in two fits with MSPS data) contrary to expectation. For the price variables also we get unexpectedly positive coefficients from these fits. Thus in all aspects, the estimates of the demand functions for paper and paperboard in India from the percentage deviations of the variables around their trends are insignificant and inconsistent with the reality. In fact, they tell us nothing about the nature of the demand functions for paper and paperboard in India. The inferior quality of data seems to be the main reason for all this. Since the fits are insignificant, so the question of accepting them for practical purpose does not arise. We have to reject them infavour of the regression fits derived from the time series of the variables.

Regression Fits from 'Percent Deviations Around Trend' Series of Data:

Variables: d : consumption of a particular category of paper;

s : No. of students;

p : Price of paper;

y : Nonfarm National Income.

All variables are in terms of % deviations around their trend.

1. Total Paper & Paperboard (Excluding Newsprint):

CMI:ASI Series:

$$\text{(i)}\quad d = 0.08871 + \underset{(0.30)}{0.44764\, y} - \underset{(-0.23)}{0.15552\, s} + \underset{(1.40)}{0.42315\, p}$$

$$R = 0.450; \quad F = 0.934; \quad d = 1.97$$

$$\text{(ii)}\quad d = 0.14275 + \underset{(0.76)}{0.90012\, y} - \underset{(-0.66)}{0.44743\, s}$$

$$R = 0.244; \quad F = 0.38; \quad d = 1.86;$$

MSPS Series:

$$\text{(i)}\quad d = 0.0327 + \underset{(1.01)}{1.32499\, y} + \underset{(0.77)}{0.46466\, s} + \underset{(0.52)}{0.13808\, p}$$

$$R = 0.310; \quad F = 0.39; \quad d = 2.48;$$

(ii) $d = 0.05390 + 0.88519y + 0.36940\ s$

$(0.91) \qquad (0.67)$

$R = 0.2722; \quad F = 0.48; \quad d = 2.52;$

2. Printing and Writing Papers:

CMI:ASI Series:

(i) $d = 0.13887 + 1.53076\ y - 0.37868s + 0.69860\ p$

$(0.91) \qquad (-0.43) \qquad (0.76)$

$R = 0.522; \quad F = 1.374; \quad d = 2.03;$

(ii) $d = 0.16786 + 0.11797\ y - 0.75864\ s$

$(0.07) \qquad (-0.83)$

$R = 0.257; \quad F = 0.426; \quad d = 1.72;$

MSPS Series:

(i) $d = -0.22945 + 2.47108\ y - 0.00547\ s + 0.3080\ p$

$(1.44) \qquad (-.006) \qquad (0.76)$

$R = 0.433; \quad F = 0.848; \quad d = 1.61;$

(ii) $d = -0.21667 + 1.84821\ y - 0.17299\ s$

$(1.25) \qquad (-0.21)$

$R = 0.381; \quad F = 1.016; \quad d = 1.54;$

4.5 Projection of Demand for Paper and Paperboard for the Years 1968-69 & 1973-74:

The estimate of the future demand for paper and paperboard in India is an important part of this study, We will now do this with the help of the demand functions that we have fitted for different categories of paper and paperboard. For some categories of paper and paperboard viz., newsprint, printing and writing papers and total paper and paperboard, we have two types of fits. In the first type we have used the current deflated national income as the explanatory variable while in the second type we have taken the trend value of national income or what we call as 'permanent income' as the explanatory variable. The difference between these two types of fits is almost negligible. Therefore, for simplicity in the projection of demand for these categories of paper and paperboard,we will use the first type of fits i.e. those having the national income (deflated current value) as the explanatory variable. The projection of demand for different categories of paper and paperboard will be made only for the Fourth Five Year Plan period which is going on. This will provide us an opportunity to compare our estimates with the estimates of the Planning Commission. For this we will estimate the demand for paper and paperboard for the year 1968-69 i.e. the year just before the beginning of the Fourth Five Year Plan and for the year 1973-74 when it will terminate. The

difference in the estimates of the demand for paper and paperboard for these two years will cover the Fourth Five Year Plan period.

Our estimates of the demand functions for different categories of paper and paperboard are based on the conventional national income series which is now available upto the year 1967-68. In the absence of the conventional estimates of national income for the year 1968-69 and 1973-74 we may, therefore, use the revised national income estimates at 1960-61 prices which are available. The following table shows these estimates for the years 1968-69 and 1973-74.

Table 4.10

Estimates of National Income 1968-69, 1973-74

	1968-69	1973-74
1. National Income		
at 1960-61 Prices	Rs.16835 crores	Rs.21380 crore[s]
Index (1950-51 = 100)	(190)	(240)
2. Non-Farm National Income		
at 1960-61 Prices	Rs.9370 crores	Rs.12696 crore[s]
Index (1950-51=100)	(234)	(302)

Sources: Planning Commission : Fourth Five Year Plan 1969-7[4]
Derived from Table 1 (p.6) and Table 8(p.63).

The estimates of national income or nonfarm national income in index form (with 1950-51 = 100) shown in the table above have been used to project the demand for different categories of paper and paperboard for the years 1968-69 and 1973-74. The projected demand for different categories of paper and paperboard and the type of demand function used for this purpose are given in the following table.

Table 4.11

Projection of Demand for Paper & Paperboard 1968-69, And 1973-74

(Thousand Tonnes)

Categories of paper and paperboard	Type of Demand Function Used	1968-69 Actual Demand	1968-69 Projected Demand	1973-74 Projected Demand
CMI:ASI Series				
1. Printing & Writing paper.	(1) Linear Fit with NI	NA	444	655
	(2) Log Fit with NI		(537)	(790)
2. Wrapping and 'other papers'	(1) Linear fit with NFI	NA	127	267
3. Paperboard	(1) Linear Fit with NFI	NA	240	337
Total (1+2+3)		NA	811	1159
4. Total Paper & Paperboard (Excluding newsprint) Single Fit.	(1) Linear fit with NI	NA	788	1144
	(2) Log Fit with NI		(859)	(1348)

Categories	Type of Demand function used	1968-69 Actual Demand	1968-69 Projected Demand	1973-74 Projecte Demand
MSPS Series:				
1. Printing & Writing paper	(1) Linear fit with NI	NA	398	577
	(2) Log Fit with NI	NA	(463)	(716)
2. Wrapping & 'other papers'	(1) Linear fit with NFI	NA	137	187
3. Paperboard	(1) Linear Fit with NFI	NA	117	164
Total (1+2+3)		645	652	928
4. Total paper & paperboard (Excluding Newsprint) Single fit:	(1) Linear Fit with NI	"	636	912
	(2) Log Fit with NI	"	(743)	(1125)
Newsprint:	(1) Linear Fit with NI only	145.5	160	219

Notes: (1) NI : means National Income as explanator variable.

(2) NFI: means Non-Farm National Income as explanatory variable.

As shown in the table, from the logarithmic fits we have got too much overestimation of the demand for printi and writing papers and for the total paper and paperboard. From the linear fits the estimates of demand for these

categories of paper and paperboard are fairly consistant with the actual consumption figures. This is evident from the fact that in the year 1968-69 the total consumption of paper and paperboard taking the MSPS data into account, was around 645 thousand tonnes. This is very close with the estimated demand of 652 thousand tonnes for this which we got from the linear fits. This shows that demand for paper and paperboard, especially for the printing and writing paper in India, is a linear function of national income and not the logarithmic function which we have found earlier. The logarithmic demand functions may, therefore, be rejected in favour of the linear demand functions which have given fairly reliable projections. Thus, disregarding the bracketed figures which we got from the logarithmic demand functions, the total projected demand for paper and paperboard, taking into consideration the CMI: ASI data, is of the order of 1159 thousand tonnes for the year 1973-74. Of this printing and writing papers (excluding newsprint) had a share of 655 thousand tonnes, wrapping and other papers' 167 thousand tonnes, and paperboard 337 thousand tonnes. The MSPS consumption data which takes into account the production of large scale units only, gives lower projection of demand for different categories of paper and paperboard (except for wrapping and other varieties) than the CMI:ASI data. According to this, the total projected demand for paper and paperboard for the year 1973-74 is of

the order of 928 thousand tonnes of which printing and writing paper had a share of 577 thousand tonnes, wrapping and other varieties 187 thousand tonnes and paperboard 164 thousand tonnes.

The Indian Planning Commission, taking the MSPS data into account, has fixed a target of 850 thousand tonnes for production of paper and paperboard (excluding newsprint) for the year 1973-74. Comparing this with our projection of demand for paper and paperboard from this data (928 thousand tonnes) we find a gap of 78 thousand tonnes between demand and domestic supply of paper and paperboard for that year. Further, if we take the entire industry into account i.e. small scale as well as the large scale sectors, the total domestic supply of paper and paperboard during the year 1973-74 may be around 1060 thousand tonnes (850 tonnes from the large scale sector of the industry as the target fixed by the Planning Commission plus roughly 25% of it coming from the small scale sector). Comparing this with our projection of the demand of 1159 thousand tonnes with the CMI:ASI data, we find a gap of 99 or say 100 thousand tonnes between the demand and supply of paper and paperboard for the year 1973-74. Thus, in both the cases targets envisaged for the production of paper and paperboard fall considerably short of the projected demand for it for the year 1973-74. It means, by the end of the Fourth Five Year

Plan period, the country may face a paper scarcity unless the capacity of production of the industry is not expanded beyond the target fixed or heavy imports of paper and paperboard are not resorted to. It has already begun. At present the country is facing considerable shortage of paper and paperboard[1].

The projections of newprint demand shown in the table above have been made taking into account the anticipated growth of the national income only. 'Import price' of newsprint which we found a significant demand factor, could not be taken into account in view of the difficulty associated with its estimation. For the year 1973-74, we estimated a demand of 219 thousand tonnes for newsprint in the country. It may not be difficult to meet this much demand for newsprint in the year 1973-74 if the plan target for production of 150 thousand tonnes of newsprint for this year is achieved and substantial imports of newsprint are made, otherwise, we are sure to have a shortage of newsprint also in the near future.

4.6 Summary and Conclusion:

The objective of this chapter was to analyze the demand for paper and paperboard in India by fitting a set of

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1. The following references throw light on the current supply of paper and paperboard in India: Eastern Economist, Vol.57 (1971, pp.50-51); Ramakrishna & Vijayalakshmi (1971); Economic & Political Weekly Vol V. (1971, p.4).

econometric models covering the period 1950-65. The analysis has been made with two alternative consumption series for each category of paper and paperboard. The first series which we called by the name of 'CMI:ASI consumption Series' took into account the output of the entire industry (small scale sector as well as the large scale sector) but the second series which we called by the name of 'MSPS Consumption Series' took into account the output of the large scale sector only. In the econometric analysis of the demand for paper & paperboard both the series were found equally good. Only the quantitative results obtained from the second series were lower in magnitudes.

The chapter has been divided into two parts. In the first part we have made a brief description of the historical trends in the growth of the consumption of paper and paperboard in India during the period 1950-1965. From this description we have found an almost stable pattern of the demand for paper and paperboard in the country during the period under review. Cultural papers comprising of the printing and writing papers and newsprint, had a share of about 65% in the total consumption of paper and paperboard. Remaining 35% share was of the industrial papers comprising of the wrapping and miscellaneous varieties and paperboard. The overall rate of growth in the demand for paper and paperboard during the period 1950-65 was 8.3% per year.

In the second part of the chapter, we have dealt with the estimation of a set of demand functions for different categories of paper and paperboard. Taking into consideration the characteristics of demand for paper and paperboard such as heterogeneity in terms of use, extremely low proportion of its cost in the consumers' total expenditure complementarity with other events and habitual nature of consumption, we have selected explanatory variables such as national income or nonfarm national income, number of students and prices of paper and paperboard to fit the demand function for different categories of paper and paperboard in India. Preliminary estimates of the demand functions with these explanatory variables gave us the following results:

(1) Price variables were found insignificant in the demand functions for all categories of paper and paperboard except newsprint.

(2) The number of students has also been found insignificant in most of the demand functions because of the multicollinearity bias arising from the high degree of correlation between it and the national income.

In the next round of estimation, we have dropped the insignificant factors viz., the number of students and prices from the demand functions and fitted them with the national income or its variant as the sole explanatory

variable. From these revised fits we have got the following main results:

(1) In the case of printing and writing papers and newsprint, logarithmic and linear fits of the demand function were found equally good. Judged by correlation between actual and estimated values of the observations in arithmatic units, the log fits were slighly better than the linear fits, but the difference was relatively very minor. The forecasting performance of the linear fits was found better, hence we have accepted them as the best estimates of the demand functior for printing and writing papers and newsprint in India overlooking the marginal superiority of the logarithmic fits from the correlation test. However, from the logarithmic fits we have got the following income-elasticity coefficients of the demand for printing and writing papers and newsprint in this country.

	Income Elasticity coeff. of Demand Obtained from	
	Current NI	'Permanent NI'
Printing & Writing paper	2.931	2.949
Newsprint	1.440	1.448

(2) The trend value of the national income which we have taken as a measure of the 'permanent' national income, gave better estimates of the demand functions for

printing and writing paper and newsprint. But the gain over the estimates of the demand functions with the current (deflated) national income as the explanatory variable for these categories of paper was found to be extremely low. For practical purpose we may, therefore, use the current national income rather than its trend value, as the best explanatory variable for the demand of printing and writing paper and newsprint.

(3) The demand for the industrial papers comprising of the wrapping and miscellaneous varieties of paper, and paperboard, was found to be a linear function of the nonfarm national income. In other words, the marginal propensity of demand for this category of paper and paperboard with respect to the nonfarm national income was fairly stable in India during the period under review.

(4) Taking into account the Fourth Five Year Plan targets of growth in the national income and nonfarm national income, we have projected the demand for different categories of paper and paperboard for the year 1973-74 through our estimates of the demand functions for them. Comparing the total projected demand for all categories of paper and paperboard with the production target fixed by the Planning Commission for this year, we find a shortage of about 100 thousand tonnes in the domestic supply. This implies that by the end of the Fourth Five Year Plan period, the country

may face a serious shortage of paper and paperboard unless it is met through imports from abroad.

(5) Our estimates of the demand functions for different categories of paper and paperboard are not comparable with the results of the existing such studies conducted in India. We have used altogether different explanatory variables and data series (CMI: ASI Series) in fitting the demand functions, so the question of comparing them with others does not arise.

APPENDIX 4.1

BASIC DATA TABLES

Table 4.12

Consumption of Paper & Paperboard (CMI:ASI Data)

Qty. in Thousand Tons
Index 1950-51 = 100

Year	Printing & Writing Papers (Excluding Newsprint		Wrapping & other varieties		Paperboard	
	Qty.	Index	Qty.	Index	Qty.	Index
	1	2	3	4	5	6
1950-51	78.5	100.0	30.0	100.0	43.0	100.0
1951-52	92.3	117.6	41.3	137.7	49.0	114.0
1952-53	112.5	143.3	39.2	130.7	54.0	125.6
1953-54	110.1	140.3	45.2	150.7	53.1	123.5
1954-55	112.7	143.6	58.1	193.7	63.0	146.5
1955-56	137.6	175.3	60.0	200.0	84.1	195.6
1956-57	147.4	187.8	64.0	213.3	81.8	190.2
1957-58	161.0	205.1	71.2	237.0	91.7	213.3
1958-59	184.7	235.3	76.6	255.3	120.7	280.7
1959-60	208.5	265.6	78.7	262.3	126.6	293.3
1960-61	229.3	292.1	78.0	260.0	133.2	309.8
1961-62	240.5	306.4	79.6	265.3	140.4	326.5
1962-63	283.4	361.0	81.4	271.3	151.3	351.9
1963-64	348.1	443.4	88.0	293.3	160.0	372.1
1964-65	364.5	464.3	93.0	310.0	170.0	395.3

contd...

(Table 4.12 contd.)

Qty. in Thousand Tons
Index 1950-51 = 100

Year	Total Paper & Paperboard (Excluding Newsprint)		Newsprint		Total Paper & Paperboard	
	Qty.	Index	Qty.	Index	Qty.	Index
	7	8	9	10	11	12
1950-51	151.5	100.0	76.2	100.0	227.7	100.0
1951-52	182.6	120.5	50.0	65.70	232.6	102.2
1952-53	205.7	135.8	54.0	70.90	259.7	114.1
1953-54	208.4	137.6	70.0	93.20	273.4	122.3
1954-55	233.8	154.3	79.0	103.70	312.8	137.4
1955-56	281.7	185.9	78.3	103.00	360.00	158.1
1956-57	293.2	193.5	76.4	100.30	369.6	162.3
1957-58	324.0	213.8	77.0	102.40	403.9	177.3
1958-59	382.0	252.1	79.4	103.70	461.9	202.4
1959-60	413.7	272.3	96.9	126.00	509.3	223.5
1960-61	440.5	290.8	98.4	128.60	538.5	236.5
1961-62	460.5	304.0	124.1	162.90	584.6	256.7
1962-63	516.1	340.7	125.8	165.10	641.9	281.9
1963-64	596.1	393.5	125.9	165.20	721.9	317.0
1964-65	627.5	414.2	131.3	172.30	758.8	333.2

Source: Derived from Tables 4.15 & 4.17.

Table 4.13

Consumption of Paper & Paperboard (MSPS Series)

Qty. in Thousand Tons
Index 1950-51 = 100.

Year	Printing & Writing Papers (Excluding Newsprint)		Wrapping & Other Papers		Paperboard	
	Qty.	Index	Qty.	Index	Qty.	Index
	1	2	3	4	5	6
1950-51	81.8	100.0	32.5	100.0	23.5	100.0
1951-52	94.7	115.8	41.9	128.9	25.9	110.2
1952-53	111.8	136.7	38.0	116.9	25.9	110.2
1953-54	116.7	142.7	41.9	128.9	24.3	103.4
1954-55	122.5	149.8	44.9	138.2	32.0	136.2
1955-56	141.6	173.1	57.0	175.4	43.5	185.1
1956-57	138.9	169.8	62.7	192.9	41.0	174.9
1957-58	147.1	179.8	66.8	205.5	42.7	181.7
1958-59	173.2	211.7	71.5	220.0	55.8	237.4
1959-60	190.3	232.6	72.6	223.4	57.3	243.8
1960-61	225.6	275.8	82.6	254.2	60.3	256.6
1961-62	236.6	289.2	86.2	265.2	67.0	285.1
1962-63	255.5	312.3	88.4	272.0	73.0	310.6
1963-64	309.5	378.4	91.8	282.5	77.6	330.2
1964-65	325.6	398.0	100.8	310.2	84.4	359.1

contd...

(Table 4.13 contd.)

Qty. in Thousand Tons
Index 1950-51 = 100.

Year	Total Paper & Paperboard (Excluding Newsprint)		Newsprint		Total Paper & Paperboard	
	Qty.	Index	Qty.	Index	Qty.	Index
	7	8	9	10	11	12
1950-51	137.8	100.0	76.2	100.0	213.0	100.0
1951-52	162.5	117.9	50.0	65.70	212.5	99.8
1952-53	175.7	127.5	54.0	70.90	229.7	107.8
1953-54	182.9	132.7	70.0	93.20	252.9	118.7
1954-55	199.4	144.7	79.0	103.70	278.4	130.7
1955-56	242.1	175.7	78.3	103.00	320.4	150.4
1956-57	242.7	176.1	76.4	100.30	319.1	149.8
1957-58	256.6	186.2	77.9	102.40	334.5	157.0
1958-59	300.5	218.1	79.4	103.70	379.5	178.2
1959-60	320.2	232.4	96.9	126.00	416.2	195.4
1960-61	389.8	282.9	124.1	162.90	513.9	241.3
1961-62	416.9	302.5	125.8	165.10	544.7	255.7
1962-63	478.9	347.5	125.9	165.20	604.7	283.9
1964-65	510.8	370.7	131.3	172.30	642.1	301.5

Table 4.14

National Income: Conventional Series (at 1948-49 Prices)

Year	National Income		Non-Farm National Income		Percapita N.I.	
	Rs. 00 Crores	Index	Rs. 00 Crores	Index	Rs.	Index
1	2	3	4	5	6	7
1950-51	88.5	100.0	39.9	100.0	247.5	100.0
1951-52	91.0	102.8	41.4	103.8	250.3	101.1
1952-53	94.6	106.9	43.2	108.3	255.7	103.3
1953-54	100.3	113.3	44.8	112.3	266.2	107.6
1954-55	102.8	116.2	46.6	116.8	267.8	108.2
1955-56	104.8	118.4	48.6	121.8	267.8	108.2
1956-57	110.0	124.3	51.2	128.3	275.6	111.4
1957-58	108.9	123.1	52.3	131.1	267.3	108.0
1958-59	116.5	131.6	54.2	136.1	280.1	113.2
1959-60	117.6	132.9	56.7	142.1	279.2	112.8
1960-61	127.3	143.8	61.3	153.6	293.2	118.5
1961-62	130.6	147.6	64.0	160.4	294.3	118.9
1962-63	133.1	150.4	67.6	169.4	293.4	118.5
1963-64	139.7	157.9	72.2	181.0	301.1	121.7
1964-65	150.5	170.1	77.4	194.0	316.0	127.7

contd....

(Table 4.14 contd.)

Year	Trend Value of National Income (Index)	Trend Value of Non-Farm N.I. (Index)	No. of Students Lakhs	Index
	17	28	39	104
1950-51	99.5	97.6	255.4	100.0
1951-52	103.1	102.2	265.3	103.9
1952-53	106.9	107.0	275.2	107.8
1953-54	110.8	111.9	291.4	114.1
1954-55	114.8	117.2	312.7	122.4
1955-56	119.1	122.7	339.2	132.8
1956-57	123.2	128.5	360.1	141.0
1957-58	127.7	134.4	379.9	148.7
1958-59	132.3	140.8	414.7	162.4
1959-60	137.2	147.4	445.3	174.4
1960-61	142.1	154.3	479.6	187.8
1961-62	147.3	161.4	542.8	212.5
1962-63	152.6	169.0	579.8	227.0
1963-64	158.2	177.0	616.9	245.5
1964-65	164.0	185.1	650.0	254.5

Table 4.15

Production, Imports and Consumption of Paper & Paperboard (Excluding Newsprint)
"CMI:ASI DATA" Basic Series (000 Tons)

Year	Printing & Writing Papers			Wrapping & Other Varieties		
	Production	Import	Consumption	Production	Import	Consumption
	1	2	3	4	5	6
1950-51	69.76	8.70	78.46	19.50	10.50	30.00
1951-52	80.30	12.00	92.30	27.30	14.00	41.30
1952-53	93.52	19.00	112.52	25.50	13.70	39.20
1953-54	90.05	20.00	110.05	28.70	16.50	45.20
1954-55	96.70	16.00	112.70	43.50	14.60	58.10
1955-56	117.57	20.00	137.57	40.00	20.00	60.00
1956-57	132.43	15.00	147.43	47.00	17.00	64.00
1957-58	147.03	14.00	161.03	49.60	21.60	71.20
1958-59	170.68	14.00	184.68	55.00	22.00	77.00
1959-60	199.48	9.00	208.48	70.00	8.70	78.70
1960-61	220.32	9.00	229.32	67.00	11.00	78.00
1961-62	232.47	8.20	240.47	65.10	14.50	79.60
1962-63	276.43	7.50	283.43	75.90	5.50	81.40
1963-64	339.58	8.50	348.08	81.20	6.80	88.00
1964-65*	360.00	4.50	365.50	86.60	6.40	93.00

contd...

(Tables 4.15 contd.)

Year	Board (All Kinds) Production	Import	Consumption	Total Consumption of Paper & Paperboard
	7	8	9	10
1950-51	39.81	3.20	43.00	151.50
1951-52	46.98	2.00	49.00	182.60
1952-53	49.26	4.70	54.00	205.70
1953-54	49.32	3.80	53.10	208.40
1954-55	57.03	6.40	63.00	233.80
1955-56	73.08	11.00	84.10	281.70
1956-57	76.91	4.90	81.80	291.20
1957-58	88.16	3.50	91.70	324.00
1958-59	118.00	2.70	120.70	382.00
1959-60	124.58	1.50	126.10	413.30
1960-61	131.11	2.10	133.20	440.50
1961-62	138.35	2.00	140.35	460.50
1962-63	149.28	2.00	151.30	516.10
1963-64	160.74	0.00	160.00	596.10
1964-65*	170.00	0.00	170.00	627.50

*Figs. are estimated.

Source: 1. Production Figs. for the financials years have been averaged out from the CMI:ASI reports which give these figs. for the calender years.

2. Imports figs. have been taken from:
   (a) Journal of Industry & Trade, various issues.
   (b) N.C.A.E.R., Demand Forecasting for Bamboo Sulphat Pulp: New Delhi: 1965.

3. Net Inventories and Exports being negligible, have been discarded.

Table 4.16

Production, Import & Consumption of Paper & Paperboard (Excluding Newsprint):M.S.P.S.Data Basic Series Qty. 000 Ton

Year	Printing & Writing Paper			Wrapping & Others		
	Production	Import	Consumption	Production	Import	Consumption
	1	2	3	4	5	6
1950-51	73.10	8.70	81.80	22.00	10.50	32.50
1951-52	82.70	12.00	94.70	27.90	14.00	41.90
1952-53	93.00	18.80	111.80	24.30	13.70	38.00
1953-54	97.40	19.30	116.70	25.40	16.50	41.90
1954-55	107.50	15.00	122.50	30.30	14.60	44.90
1955-56	121.80	19.80	141.60	37.10	20.00	59.00
1956-57	123.90	15.00	138.90	45.60	17.00	62.70
1957-58	133.50	13.60	147.10	45.20	21.60	66.80
1958-59	160.20	13.00	173.20	49.90	21.60	71.50
1959-60	186-40	3.90	190.30	63.90	8.70	72.60
1960-61	216.60	9.00	225.60	71.60	11.00	82.60
1961-62	228.84	8.20	236.60	71.70	14.50	86.20
1962-63	248.00	7.50	255.50	82.90	5.50	88.40
1963-64	301.00	8.50	309.50	85.00	6.80	91.80
1964-65	321.10	4.50	325.60	94.40	6.40	100.80

(Table 4.16 contd.)

Year	Board Production	Board Import	Board Consumption	Total Consumption
	7	8	9	10
1950-51	20.30	3.20	23.50	137.80
1951-52	23.70	2.00	25.70	162.30
1952-53	21.20	4.70	25.90	175.70
1953-54	20.50	3.80	24.30	182.90
1954-55	25.60	6.40	32.00	199.40
1955-56	32.50	11.00	43.50	242.10
1956-57	36.20	4.90	41.10	242.70
1957-58	39.20	3.50	42.70	256.60
1958-59	53.10	2.70	55.80	300.50
1959-60	55.80	1.50	57.30	320.20
1960-61	58.20	2.10	60.30	368.50
1961-62	65.00	2.00	67.00	389.80
1962-63	71.10	2.00	73.00	416.90
1963-64	77.60	0.00	77.60	478.90
1964-65	84.40	0.00	84.40	510.80

Source: Production figs. have been taken from Monthly Statistics of Production of Selected Industries.

Net Inventories & Exports being negligible, have been discarded.

Table 4.17

Production, Import & Consumption of Newsprint: Basic Series

Year	Production 000 Tons	Import 000 Tons	Consumption 000 Tons
1950-51	0.0	76.2	76.2
1951-52	0.0	50.0	50.0
1952-53	0.0	54.0	54.0
1953-54	0.0	70.0	70.0
1954-55	0.0	79.0	79.0
1955-56	3.6	74.7	78.3
1956-57	13.6	62.8	76.4
1957-58	14.2	63.7	77.9
1958-59	21.9	57.5	79.4
1959-60	22.4	74.5	96.9
1960-61	22.9	75.5	98.4
1961-62	25.7	98.4	124.1
1962-63	24.9	99.4	125.8
1963-64	30.4	95.9	125.9
1964-65	32.0	99.3	131.3

Sources:

1. Government of India: Planning Commission: Programmes for Industrial Development: 1956-61.
2. U.N.O.: Statistical Year Books, 1960, 1961 & 1965.

Table 4.18

Percapita Consumption of Total Paper & paperboard (Excluding Newsprint)

Year	CMI:ASI Series		MSPS Series	
	Qty.(Kg)	Index	Qty(Kg)	Index
1950-51	0.4322	100.0	0.3931	100.0
1951-52	0.5123	118.5	0.4559	116.0
1952-53	0.5671	131.2	0.4844	123.2
1953-54	0.5642	130.5	0.4951	126.0
1954-55	0.6213	143.8	0.5298	134.8
1955-56	0.7342	169.9	0.6311	160.5
1956-57	0.7493	173.4	0.6203	157.8
1957-58	0.8470	196.0	0.6424	163.4
1958-59	0.9734	225.2	0.7369	187.5
1959-60	1.0243	236.4	0.7754	197.3
1960-61	1.0349	239.5	0.8654	220.2
1961-62	1.0349	244.9	0.8970	227.9
1962-63	1.1605	268.5	0.9374	238.5
1963-64	1.3105	303.2	1.0528	267.8
1964-65	1.3438	311.0	1.0940	278.3

Table 4.19

Data % Deviations from Trend Series

Year	Non-Farm NI	No.of Students	Price for Total Paper & Paperboard	Price for Printing & Writing Paper
1	2	3	4	5
1950-51	-0.99	2.04	-1.03	-4.02
1951-52	-0.39	0.50	0.30	5.55
1952-53	0.47	-1.46	-1.50	1.98
1953-54	0.54	-1.64	2.88	-2.83
1954-55	0.78	-0.89	-1.30	-1.66
1955-56	0.91	0.91	-1.80	-2.68
1956-57	1.91	0.21	-3.32	-2.30
1957-58	-0.46	-1.49	-3.30	-4.19
1958-59	-1.30	0.12	12.10	8.90
1959-60	-2.00	-0.23	7.67	4.25
1960-61	0.65	-0.61	-7.97	-3.92
1961-62	-0.44	3.76	-3.52	-3.18
1962-63	-0.59	3.02	0.90	1.23
1963-64	0.39	1.02	1.32	2.20
1964-65	1.10	-3.75	-1.34	1.67

Contd...

(Table 4.19 contd.)

Year	Consumption of Total Ppaper & Paperboard: CMI: ASI SERIES	Consumption of Total Ppaper & Paperboard: MSPS SERIES	Consumption of Printing & Writing Papers only: CMI: ASI SERIES	Consumption of Printing & Writing Papers only: MSPS SERIES	Total Paper & P.B. ESRF Series
1	6	7	8	9	10
1950-51	-6.48	-3.30	-2.36	-4.25	8.10
1951-52	1.56	3.96	3.58	-1.93	1.56
1952-53	4.15	2.63	13.30	9.40	-0.60
1953-54	-6.63	-2.45	0.27	4.00	-2.59
1954-55	-2.90	-3.02	-8.17	-0.40	1.78
1955-56	5.90	7.60	0.80	4.42	4.75
1956-57	-0.10	-1.82	-2.83	-6.77	-5.21
1957-58	0.0	-4.92	-4.45	-10.14	-8.88
1958-59	7.05	1.55	-1.44	-3.62	-9.92
1959-60	4.63	-1.50	0.10	-3.64	-1.10
1960-61	0.60	3.55	-0.91	3.82	-0.80
1961-62	-4.46	0.0	-6.60	-0.89	6.68
1962-63	-2.60	-2.59	-1.01	-2.48	6.14
1963-64	1.63	2.33	9.36	7.47	3.58
1964-65	-3.04	-0.43	3.11	2.91	0.36

Table 4.20

Stocks of Finished Products & By Products with the Industry

Year	Value (Rs.Lakhs)	Price of Paper & P.B.(Rs.) Per Ton	Quantity (000 Tons)	Net change in Qty. (000 Tons)	Total apparent consumption of paper & P.B. (Production + Imports)
1948	78.5	971.0	8.08	-	-
1949	128.8	1085.7	11.90	3.82	-
1950	87.0	1127.2	7.72	-4.18	151.50
1951	90.4	1254.8	7.20	-0.52	182.6
1952	100.0	1226.9	8.15	0.95	205.7
1953	115.2	1211.5	9.50	1.35	208.4
1954	102.0	1211.5	8.41	-1.09	233.8
1955	166.0	1212.6	13.70	5.29	281.7
1956	192.0	1231.3	15.60	1.90	291.2
1957	129.5	1224.3	10.60	-5.00	324.0
1958	125.0	1403.5	8.90	-1.70	382.0
1959	159.4	1358.7	11.70	2.80	413.3
1960	304.1	1230.0	24.70	13.00	440.5
1961	379.1	1289.5	29.40	4.70	460.5
1962	398.4	1362.9	28.80	-0.60	516.10
1963	511.0	1390.5	36.74	7.94	596.10
1964	649.8	1352.2	48.00	11.26	627.5
1965	746.9	1360.5	54.85	6.85	-

Source: CMI:ASI Reports

Appendix 4.2

Some Rejected Regression Fits

Variables: 'D' is the index of Qty. of the relevant category of Paper and paperboard consumed;

y_2 is the index of non-farm national income;

S is the index of number of students;

and P is the price 'Δ' indicates 'first difference' of the variable.

1. Total Paper and Paperboard (Excluding Newsprint):

<u>CMI:ASI Series</u>:

(i) $$D = -164.39699 + \underset{(1.43)}{1.94432\, y_2} + \underset{(1.10)}{0.820235}$$

$R = 0.991$; $F = 346.1$;

(ii) $$\ln(D) = -1.8849 + \underset{(0.15)}{0.17843 \ln(y_2)} + \underset{(1.66)}{1.26602 \ln(S)}$$

$R = 0.985$; $F = 191.44$;

(iii) $$\Delta D = 4.5412 - \underset{(-0.48)}{0.61167 \Delta y_2} + \underset{(2.24)}{2.139 \Delta S}$$

$R = 0.597$; $F = 3.05$;

(iv) $$\Delta D = 13.67112 + \underset{(1.187)}{0.79807 \Delta S}$$

$R = 0.342$; $F = 1.409$;

MSPS Series:

(i) $D = -142.71273 + 1.88989\ y_2 + 0.58802$

$$\qquad\qquad (2.93) \qquad\qquad (1.06)$$

$R = 0.997; \qquad F = 1137.0$

(ii) $\ln(D) = -2.33946 + 0.70747\ \ln(y_2) + 0.82341\ \ln(S)$

$$\qquad\qquad (1.00) \qquad\qquad (1.80)$$

$R = .993; \qquad F = 459.4;$

(iii) $\triangle D = 8.19751 + 1.01586\ \triangle S$

$$(1.766)$$

$R = 0.454; \qquad F = 3.12;$

(iv) $\triangle D = -3.23721 + 1.03384\ \triangle y_2 + 1.51446\ \triangle S$

$$\qquad\qquad (1.03) \qquad\qquad (1.99)$$

$R = 0.71; \qquad F = 5.73;$

2. Printing & Writing Papers:

CMI:ASI Series:

(i) $D = -277.46731 + 3.40868\ y_2 + 0.29902\ S$

$$\qquad\qquad (2.29) \qquad\qquad (0.365)$$

$R = 0.992; \qquad F = 394.5;$

(ii) $\ln(D) = -4.82455 + 1.6404\ \ln(y_2) + 0.4272\ \ln(S)$

$$\qquad\qquad (1.95) \qquad\qquad (0.798)$$

$R = .993; \qquad F = 443.7;$

MSPS Series:

(i) $D = -195.03636 + 2.61036\, y_2 + 0.33643\, S$

$(2.417) \qquad (0.57)$

$R = 0.994; \qquad F = 495.7;$

(ii) $\ln(D) = -4.07672 + 1.64046 \ln y_2 + 0.2648$

$(2.163) \qquad (0.54)$

$R = 0.993; \qquad F = 430.79;$

3. Wrapping and Miscellaneous Paper:

CMI:ASI Series:

(i) $D = 64.2456 + 2.07904\, y_2 - 1.26935\, P$

$(5.24) \qquad (-0.46)$

$R = 0.835; \qquad F = 13.86;$

(ii) $\ln(D) = 0.78706 + 1.52809 \ln(y_2) - 0.63635 \ln(P)$

$(5.76) \qquad (-0.50)$

$R = 0.858; \qquad F = 16.74;$

MSPS Series:

(i) $D = 141.0590 + 2.2601\, y_2 + 0.33116\, P$

$(14.13) \qquad (0.30)$

$R = 0.973; \qquad F = 104.60;$

(ii) $\ln(D) = -3.8724 + 1.6834 \ln(y_2) + 0.18967 \ln(P)$

$(11.90) \qquad (0.28)$

$R = 0.962; \qquad F = 74.13;$

4. Paperboard:

CMI:ASI Series:

(i) $D = -320.8493 + 3.18018\, y_2 + 1.21863\, P$

$$\qquad\qquad (12.4) \qquad\qquad (1.069)$$

$R = 0.978;$ $\quad F = 133.5;$

(ii) $\ln(D) = -6.98277 + 2.06898 \ln(y_2) + 0.48107 \ln(P)$

$$\qquad\qquad (10.27) \qquad\qquad (1.26)$$

$R = 0.968;$ $\quad F = 9013;$

MSPS Series:

(i) $D = -264.46185 + 2.79855\, y_2 + 0.90152\, P$

$$\qquad\qquad (12.02) \qquad\qquad (1.07)$$

$R = 0.985;$ $\quad F = 207.1;$

(ii) $\ln(D) = -662812 + 1.95978 \ln(y_2) + 0.49549 \ln(P)$

$$\qquad\qquad (11.05) \qquad\qquad (1.27)$$

$R = 0.973;$ $\quad F = 105.9;$

Note: Equations which were found inferior in statistical sense than the equations shown above were discarded. We have not reported them in this appendix.

CHAPTER 5

EMPIRICAL ESTIMATES OF THE PRODUCTION FUNCTION FOR INDIAN PAPER INDUSTRY:

5.1 Introduction:

The production function is a highly abstract concept that has been evolved to deal with the technological aspect of the theory of production. It is an embodiment of the technology which yields maximum output from the given set of inputs or specifies the way in which inputs cooperate with each other to produce a given level of output[1]. It is a technologically determined physical relationship which enters economic analysis as datum. The technology embedded in it acts as a constraint on economic decision making. A manufacturer cannot go out of the technological alternatives specified by the production function, but the one he chooses among themselves, is a matter of economic considerations related primarily to the input prices. The realm of the production function is ideally a plant which is considered as the smallest

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1. The following sources elaborate the concept of production function: Schumpter (1954, P.,1027); Brown (1966, P.9); Dorfman, et al (1958 PP. 130-133); Klein (1962, P.62); Salter (1961, PP.1-10); Cramer (1969, P.224).

technical unit producing a homogeneous commodity, but it can easily be extended to a firm, an industry or even the entire productive sector of a country.

The technology embodied in a production function can be expressed in terms of four characteristics. These are: (1) the 'efficiency' of the technology; (2) the degree of 'economies of scale; (3) the degree of capital or labour intensity; and (4) the 'ease' with which capital is substituted for labour or vice versa. These four characteristics of the production function are extremely useful in the economic analysis. An increase in the 'efficiency' of a technology increases the output for the given level of inputs and other characteristics of the technology. It may be considered as a parameter showing the overall quality of the technology. After defining the dimensions of inputs, it is a scale transformation of inputs into output. The degree of 'economies of scale' is an important characteristic showing the proportionate increase in the output from the proportionate increase in all inputs. If the output increases by a larger proportion than the inputs, the firm or industry enjoys 'increasing returns' or economies of scale. If the output increases by the same proportion as the inputs, the firm or industry gets 'constant returns' to scale and when it is smaller, 'decreasing returns' or

diseconomies of scale result. The third characteristic expresses the quantity of capital relative to the quantity of labour used in production. It indicates the influence of capital and labour on the output of the firm or industry. The fourth characteristic reveals the extent to which the factor proportions, mainly the capital labour ratio, can be changed with the changes in the relative marginal products or prices of the factors of production. In other words, this gives us a measure of the elasticity of substitution (Hicks, 1963, PP. 119-135) between different factors of production such as capital and labour.

In this chapter our objective is to estimate a production function for the Indian paper industry and thus, to study the four characteristics of the technology embodied in it. The analysis is to be carried on with the aggregate data of the industry details of which are given in chapter 2. This will give us average results regarding the technological characteristics of production for all the firms operating in the industry during the period 1949-1964. Individual firms or units engaged in production of paper and paperboard in the country during this period, might have been operating at different levels of the technology which can be known by estimating the production function separately for each of them. But, we are unable to do so because of the nonavailability of

inter firm data for the industry. The aggregate data on the other hand is available from the CMI and ASI reports (Ref: Ch. 2), with the use of which only aggregate production functions can be fitted for the industry.

5.2 The Choice of Model:

For measuring the technological characteristics mentioned above two types of production functions are generally used. These are: (1) the Cobb-Douglas production function (Cobb and Douglas, 1928) and (2) the Constant Elasticity of Substitution or CES production function (Arrow, et al 1961). The Cobb-Douglas production gives explicit measurement of the first three characteristics, viz., the efficiency of the technology, the degree of returns to scale and the contribution of different factors of production in the output of the firm or industry for which the function is fitted. The fourth characteristic, namely the elasticity of substitution between capital and labour takes unitary value in the Cobb-Douglas production function which is its serious limitation (Allen, 1950). This limitation has been removed in the CES production function which gives an explicit measurement of the elasticity of substitution along with the other three characteristics. The CES as well as the Cobb-Douglas production functions presume constant elasticity of substitution. This restriction has been removed by

Revankar (1967), Lu (1967), and Lu and Fletcher (1968) in the recent generalizations of the C.E.S. production function in which the elasticity of substitution no longer remains constant but varies with the changes in the capital labour ratio. They call it by the name of 'Variable Elasticity of Substitution or VES' production function. Thus, we have now three alternative specifications of the production function i.e. the Cobb-Douglas, the CES and the VES production functions. All these three specifications of the production function provide us the basic framework for the empirical analysis that we intend to do in this chapter. Since the VES production function is a generalization of the CES production function which, in turn, is a generalization of the Cobb-Douglas production function, we will, therefore, estimate it first for the Indian paper industry and see whether the industry had variable or constant elasticity of substitution between capital and labour during the period 1949-64.

5.3 Estimate of the VES Production Function for the Indian Paper Industry:

As we know, the derivation of the CES production function is based on the assumption of "the existence of a relationship between value added per unit of labour ($\frac{V}{L}$) and the wage rate (W) independent of the capital stock" (Arrow, et al, 1961, p. 231). This may be true only if technology is 'neutral' i.e., factor proportions do not vary.

But in the case of non-neutral technology, output may be affected by the changes in the factor proportions and, therefore, above assumption may not be valid. Taking this possibility into consideration, Lu and Fletcher (1968) modified the assumption by adding a third variable K/L to it as suggested by Hildebrand and Liu (1965). The relationship may now be expressed as:

$$\log V/L = \log a + b \log(W) + c \log \left(\frac{K}{L}\right) + e \qquad (1)$$

where a,b and c are constants, e is the error term. From this relationship a more general production function which is called as the VES production function, has been derived by Lu and Fletcher (1968) which can be expressed as:

$$V = \gamma\left[\delta K^{-\rho} + (1-\delta)\eta\left(\frac{K}{L}\right)^{-c(1+\rho)} L^{-\rho}\right]^{-\frac{1}{\rho}}$$

where: $\rho = \left(\frac{1}{b} - 1\right)$ (2)

$\eta = (1-b)/(1-b-c)$

'γ','δ' and 'ρ' are 'efficiency'; 'distribution' and 'substitution' parameters as defined in the CES production function. This production function has the same form as the CES production function except that $L^{-\rho}$ is multiplied by $\eta\left(\frac{K}{L}\right)^{-c(1+\rho)}$. If c = 0, the multiplier becomes unity and this function reduces to the CES production function. The production function is, therefore, a generalized version of the CES production

function. It has been shown by Lu (1967) that the new production function has the properties of (a) positive marginal products; (b) downward sloping marginal products over the relevant ranges of inputs; (c) homogeniety of degree one and, (d) variable elasticity of substitution.

From the production function (2) the expression for the elasticity of substitution (σ) has been derived by Lu and Fletcher (1968) as:

$$\sigma = \frac{b}{1-c\ (1+\frac{wL}{rK})} \tag{3}$$

where b and c are coefficient of eq(1) or (2), w is the wage rate, r is the rental per unit of capital and L and K are labour and capital inputs respectively. The term $\frac{wL}{rK}$ is the relative factor share which changes when the factor proportion $\frac{K}{L}$ changes giving the variable elasticity of substitution. If c=0, σ takes constant value equal to the coefficient b.

The VES production function shown above is a homogeneous function of degree one. A few generalized versions of it have been derived (Revanker (1967 and 1971); Zellner and Revanker (1969)) in which the restriction of the constant returns to scale has been removed, but their empirical relevancy has not yet been established fully.

In practice, the VES production functions are being estimated under assumption of the constant returns to scale.

To test for the variability of the elasticity of substitution we have fitted eq (1) with the time series data of the Indian paper industry covering the period 1949-1964. We assume that constant return to scale was prevailing in the industry during this period (This was in fact true as we will see in the next section). The regression fits with alternative sets of data are as follows:

Variables:

$\frac{V}{L_p}$ = Gross value Added at current price per person employed in the industry (Rs,000)

$\frac{V}{L_m}$ = Gross value Added at current price per 'manyear' worked (by the 'workers' only) in the industry. (Rs,000)

W_p = Current Wage Rate (per annum) for all persons employed in the industry (Rs.)

W_m = Current Wage Rate (per annum) for manyears worked in the industry (Rs.)

$\frac{K}{L_p}$ = Fixed Capital per person employed in the industry (Rs,000)

$\frac{K}{L_m}$ = Fixed capital per 'manyear' worked in the industry (Rs,000).

V^*/L_p, V^*/L_m, W_p^*, W_m^*, K^*/L_p and K^*/L_m are deflated values of the above variables respectively.

t is the time trend (1949 = 1).

Regression Equations:

$$(1)\ \ln \frac{V}{L_p} = -6.64691 + 1.18633 \ln W_p - 0.29781 \ln \frac{K}{L_p} + 0.02908\ t$$

$$(1.72) \qquad (-0.82)^+ \qquad (1.21)^+$$

R = 0.953; F = 39.5; d = 0.971;

$$(2)\ \ln \frac{V}{L_p} = -8.87677 + 1.46487 \ln W_p - 0.14568 \ln \frac{K}{L_p}$$

$$(2.22) \qquad (-0.43)^+$$

R = 0.95; F = 56.43; d = 1.164;

$$(3)\ \ln \frac{V}{L_m} = -6.95339 + 1.22440 \ln W_m - 0.09001 \ln \frac{K}{L_m} + 0.02118\ t$$

$$(1.30)^+ \qquad (-0.19)^* \qquad (0.71)^+$$

R = 0.932; F = 26.4; D = 1.12;

$$(4)\ \ln \frac{V}{L_m} = -7.59544 + 1.25589 \ln W_m + 0.11113 \ln \frac{K}{L_m}$$

$$(1.36) \qquad (0.29)^+$$

R = 0.929; F = 40.97; d = 1.30;

$$(5)\ \ln \frac{V^*}{L_p} = -3.53866 + 0.75986 \ln W_p^* - 0.39759 \ln \frac{K^*}{L_p} + 0.06115\ t$$

$$(1.56) \qquad (-1.17)^+ \qquad (2.55)$$

R = 0.938; F = 29.6; d = 1.06;

$$(6)\ \ln \frac{V}{L_p} = -7.04911 + 1.0277 \ln W_p^* + 0.34751 \ln \frac{K^*}{L_p}$$
$$(1.82) \qquad (1.06)^+$$
$$R = 0.903; \quad F = 28.89; \quad d = 2.02;$$

$$(7)\ \ln \frac{V^*}{L_m} = -2.07612 + 0.49761 \ln W_m^* - 0.12615 \ln K^*/L_m + 0.06044$$
$$(1.04)^+ \qquad (-0.34)^+ \qquad (2.54)$$
$$R = 0.945; \quad F = 33.39; \quad d = 1.09$$

$$(8)\ \ln \frac{V^*}{L_m} = -1.18079 + 0.06625 \ln W_m^* + .76528 \ln K^*/L_m$$
$$(0.12)^+ \qquad (5.26)$$
$$R = 0.914; \quad F = 32.995; \quad d = 1.80;$$

Note: '+' shows insignificance at 10% level.

In these fits coefficients having t value (shown in brakets) less than 1.350 (for 13 degrees of freedom) or 1.356 (for 12 degrees of freedom) at 10% level of significance are insignificant. For capital-labour ratios, we have insignificant coefficients in all equations except in equation (8) where it is significant but highly unreliable because of the high degree of multicollinearity which made the coefficient of W_m insignificant contrary to the expectation. This can, therefore, be discarded. Thus, from these fits we do not get any evidence in favour of the variable elasticity of substitution in the India paper industry. The relationship between value added per unit of labour and ~~between~~ wage rate is independent of the

capital stock (K/L) which implies constant elasticity of substitution production function for the industry.

5.4 Estimate of the CES Production Function:

Once we have established that the Indian paper industry had constant elasticity of factor substitution and not the variable elasticity, during the period under review, the next question that arises is with regard to its correct measurement. We have two different specifications of the CES production function. The original versions of it derived by Arrow, Chenery, Minhas & Solow (1961) is restricted to the constant returns to scale. Mathematically it is expressed as:

$$V = \gamma\left[\delta K^{-\rho} + (1-\delta)\ L^{\rho}\ \right]^{-1/\rho} \qquad (4)$$

Where V is the value added,

K is capital input,

L is Labour input,

'γ','δ' and 'ρ' are constants defined as 'efficiency', 'distribution' and 'substitution' parameters respectively,

The second version of the CES production function has been derived independently by Brown and de-Cani (1963) which contains a new paramter 'υ' showing the degree of returns to scale. Mathematifally this is expressed as:

$$V = \gamma\left[\delta K^{-\rho} + (1-\delta)\ L^{-\rho}\right]^{-\upsilon/\rho} \qquad (5)$$

Since this version of the CES production is free from the restriction of constant returns, it is, therefore, undoubtedly a better specification for the empirical analysis. We will, therefore, use this for measuring the elasticity of substitution and degree of returns to scale prevailing in the paper industry of India during the period 1949-64.

Before fitting the CES production function for the Indian paper industry, we shall go briefly through its properties which are related with its coefficients, 'γ', 'δ', 'υ' and 'ρ'. This may help us in interpreting the empirical results. The first coefficient 'γ' which is called as 'efficiency parameter' is a scale parameter denoting the efficiency of a technology. A change in it changes the output in the same production. Changes in it are assumed to be "neutral" i.e. neither capital or labour using or saving. The seond coefficient 'δ' is called as "distribution parameter". It gives a measure of the capital intensity of the technology. It is also interpreted as the share of capital in the income of the industry. Depending upon the nature of the technology, 'δ' takes value between 0 and 1. The coefficient 'υ' gives the degree of returns to scale. For increasing returns to scale $\upsilon>1$, for decreasing

returns to scale $\vartheta < 1$, and for constant returns to scale $\vartheta = 1$ as in the ACMS version of the CES production function. The fourth coefficient 'ρ' is a transform of the elasticity of substitution paramter (σ). The relationship between 'ρ' and 'σ' can be derived as follows:

From the ACMS version of the CES production function (eq.4) the marginal products of labour and capital can be written as:

$$\frac{\partial V}{\partial L} = \gamma(1-\delta)\, L^{-(\rho+1)} \left[\delta K^{-\rho} + (1-\delta)\, L^{-\rho}\right]^{-(1/\rho+1)}$$

and

$$\frac{\partial V}{\partial K} = \gamma(\delta)\, K^{-(\rho+1)} \left[\delta K^{-\rho} + (1-\delta)\, L^{-\rho}\right]^{-(1/\rho+1)}$$

As we know, marginal rate of substitution between capital and labour is the ratio of their marginal products. In competitive equilibrium it must also be equal to their price ratio. Therefore, we have:

$$R = \frac{\partial V}{\partial L} \Big/ \frac{\partial V}{\partial K} = \frac{w}{r} = \left(\frac{1-\delta}{\delta}\right) \frac{K}{L}^{(1+\rho)}$$

Where w is the wage rate and r is the rental value per unit of capital input. This is the substitution function for the CES production function. From this, elasticity of substitution can be derived as:

$$\text{Elasticity of substitution } (\sigma) = \frac{d\left(\frac{K}{L}\right)}{\frac{K}{L}} \Big/ \frac{dR}{R} = \frac{1}{1+\rho} \qquad (6)$$

Since 'ρ' is a constant, so the elasticity of substitution

will also be a constant. This is the most important property of the CES production function after which it has been named.

The lowest admissible value of 'ρ' for the CES production function is -1 which implies an infinite elasticity of substitution. Its maximum value is ∞ at which the elasticity of substitution takes zero value and the CES production function reduces to the Leontief's fixed factor production function (Ferguson, 1969). If ρ =0, it gives unitary elasticity of substitution and the CES production function reduces to the Cobb-Douglas production function having the form $V = \gamma K^{\delta} L^{(1-\delta)}$

The CES production function is such that ordinary least squares procedure cannot be applied to estimate it directly. Different methods have, therefore, been devised to estimate all or at least some of its parameter in successive steps (Brown, 1966). The most important use of the CES production function is in estimation of the elasticity of substitution parameter (σ), for this the conventional procedure is to equate the marginal product of labour derived from the CES production function with the wage rate assuming competive equilibrium conditions in the industry. The resulting equation being linear in logarithmic form can be fitted using the simple least - squares technique and one of its parameter gives a direct

measurement of the elasticity of substitution. The main steps in the mathematical derivation of this relationship are as follows:

Let $V = \gamma[\delta K^{-\rho} + (1-\delta) L^{-\rho}]^{-\upsilon/\rho}$; $\upsilon \neq 0$

Differenciating with respect to labour input L,

$$\frac{\partial V}{\partial L} = \upsilon \gamma^{-\rho/\upsilon}(1-\delta) L^{-(\rho+1)} V . V^{\rho/\upsilon}$$

Multiplying and dividing the right hand side by V^{ρ} and rearranging we have;

$$\frac{\partial V}{\partial L} = \upsilon \gamma^{-\rho/\upsilon}(1-\delta)\left(\frac{V}{L}\right)^{1+\rho} V^{\rho(1-\upsilon)/\upsilon} \qquad (7)$$

Assuming that the distribution of income is determined by the competitive factor pricing. So equating the wage rate with the marginal product of labour we have:

$$W = \frac{\partial V}{\partial L} = \upsilon \gamma^{-\rho/\upsilon}(1-\delta)\left(\frac{V}{L}\right)^{1+\rho} . V^{\rho(1-\upsilon)/\upsilon}$$

or $$\left(\frac{V}{L}\right)^{1+\rho} = \left[\upsilon \gamma^{-\rho/\upsilon}(1-\delta)\right]^{-1} . V^{-\rho\left(\frac{1-\upsilon}{\upsilon}\right)} W$$

or $$\log\left(\frac{V}{L}\right) = -\frac{1}{1+\rho}\log\left[\upsilon \gamma^{-\rho/\upsilon}(1-\delta)\right] - \frac{\rho}{1+\rho}\left(\frac{1-\upsilon}{\upsilon}\right)\log V + \frac{1}{1+\rho}\log W$$

or $$\log\left(\frac{V}{L}\right) = a_0 - a_1 \log V + \sigma \log W \qquad (8)$$

where $a_0 = -\sigma \log\left[\upsilon \gamma^{-\rho/\upsilon}(1-\delta)\right]$

$a_1 = (1-\sigma)\left(\frac{1-\upsilon}{\upsilon}\right)$

$\sigma = \frac{1}{1+\rho}$

Eq. (8) is used in cross-sectional studies because γ is a constant and there is no provision for technological progress or any other effect which changes with time.

For time series counterpart of it we may assume that the efficiency of the CES production function denoted by γ increases with time in a 'neutral' way, that is,

$$\gamma = e^{\lambda t} \tag{9}$$

Where λ indicates the rate of neutral technological progress. Technology is neutral in the sense that factors intensity remains constant but the production function shifts upward. With this modification, the time-series counterpart of eq(8) would be as:

$$\log \frac{V}{L} = bo - a_1 \log V + \sigma \log W + c_1 t \tag{10}$$

where $bo = -\sigma \log [(1-\delta)v]$

$a_1 = (1-\sigma)\left(\frac{1-v}{v}\right)$

$c_1 = \frac{\lambda}{v}\left(\frac{\rho}{1+\rho}\right) \quad \therefore \lambda = \frac{c_1 v(1+\rho)}{\rho}$

For constant returns to scale ($v=1$), $a_1=0$, so the term a_1 Log V drops out and we have;

$$\log \frac{V}{L} = bo' + \sigma \log W + c_2 t \tag{11}$$

where $bo' = -\sigma \log (1-\delta)$

$c_2 = \lambda\left(\frac{\rho}{1+\rho}\right) \quad \therefore \lambda = \frac{c_2 (1+\rho)}{\rho}$.

To measure the elasticity of substitution (σ) for the Indian paper industry we have fitted eq.(10) and eq.(11) using the time-series data. The fitted regression equations with current as well as deflated variables are as follows:

as follows:

Variables:

$\frac{V}{L_p}$ = Gross Value Added (at current prices) per person employed in the industry. (Rs,000).

$\frac{V}{L_m}$ = Gross Value Added (at current prices) per 'manyear' worked by workers only. (Rs,000).

V = Gross Value Added (Rs. Lakhs).

W_p = Wage Rate (per annum) for all persons employed in the industry (Rs.)

W_m = Wage Rate (per annum) for 'manyear' worked by workers only (Rs.)

$\frac{V^*}{L_p}$, $\frac{V^*}{L_m}$, V^*, W_p^* and W_m^* are deflated values of the above variables respectively.

Regression equations:

$$(1)\ \ln\frac{V}{L_p} = \underset{}{-5.95124}+\underset{(1.83)}{0.86599}\ln(W_p)+\underset{(0.79)}{0.15213}\ln(V)-\underset{(-0.12)}{0.00496}t$$

$$R = 0.953; \quad F = 39.29; \quad d = 0.694^{+}$$

$$(2)\ \ln\frac{V}{L_m} = -7.78676+\underset{(1.93)}{1.14648}\ln(W_m)+\underset{(0.8)}{0.19370}\ln V-\underset{(-0.29)}{0.01207}t$$

$$R = 0.936; \quad F = 28.26; \quad d = 0.503^{+}$$

$$(3)\ \ln\frac{V}{L_p} = -5.53539+\underset{(2.75)}{0.82259}\ln(W_p)+\underset{(1.31)}{0.13281}\ln(V)$$

$$R = 0.953; \quad F = 63.75; \quad d = 0.717^{+}$$

$$(4)\ \ln \frac{V}{L_m} = -6.74361+1.03840 \ln(W_m) + 0.14046 \ln (V)$$

(2.34) (1.16)

$R = 0.935$; $F = 45.56$; $d = 0.494^{+}$

$$(5)\ \ln \frac{V^*}{L_p} = -9.37406+0.81276 \ln(W_p^*)+0.75788 \ln(V^*)-0.06625t$$

(2.98) (5.30) (-3.19)

$R = 0.980$; $F = 96.71$; $d = 1.19^{++}$

$$(6)\ \ln \frac{V^*}{L_m} = -6.13663+0.64363 \ln(W_m^*)+0.45784 \ln(V^*)-0.00992\, t$$

(1.75) (1.89) (-0.29)

$R = 0.958$; $F = 44.08$; $d = 0.986^{++}$

$$(7)\ \ln \frac{V^*}{L_p} = -4.13384+0.43477 \ln(W_p^*) + 0.32912 \ln(V^*)$$

(1.35) (5.15)

$R = 0.963$; $F = 81.996$; $D = 1.78$

$$(8)\ \ln \frac{V^*}{L_m} = -5.37899 + 0.5939\ (W_m^*) + 0.38841 \ln (V^*)$$

(1.89) (8.18)

$R = 0.957$; $F = 71.08$; $d = 0.98^{++}$

\+ shows auto-correlation as $d < d_L$ at 5% level of significance.

++ Test of auto-correlation inconclusive $d_L < d < d_u$ at 5% level.

In the first four regression fits shown above we have used all variables except trend (t) in terms of their current values. In these fits both, value added (V) and time trend (t) have significant coefficients as shown by their t - ratios (shown in brackets) which are less than

the minimum significant limit of 1.77 for 13 degrees of freedom in fit no (1),and (2) or 1.78 for 12 degrees of freedom in fit no (3) and (4). Insignificant coefficient for value added implies absence of the increasing or decreasing returns to scale for the industry. In other words this implies the constant returns to scale prevailing in the industry during the period under study. Insignificant coefficient for time trend (t) implies absence of the neutral technological progress in the industry during the period under review. The elasticity of substitution i.e., the coefficient of ln (W_p) or ln (W_m) varies between 0.82 to 1.15 in all these four fits.

The next four fits i.e. no (5) to (8), in which deflated variables have been used, have significant coefficients for value added (V^*) and time trend (t). However, using the coefficients of value added (V^*) we find highly absurd estimates of the degree of returns to scale for the industry. From fit no (5) for example using the expression $a_o = (1 - \sigma)\ (\upsilon - 1)\ /\upsilon$ where a_o is the regression coefficient for value added, the degree of returns to scale (υ) comes out to be - 0.33. Similarly, from other fits it comes out as -3.60, 2.03 and 18.9 respectively. In view of this absurdity in the degree of

returns to scale parameter (υ), we cannot accept these fits as a fair description of some economic reality. Probably, we are getting such results because of the inferior quality of deflated data used in fitting the above production functions. For deflation of the value added, we have used the double-deflation method (David,1962) since there are no other alternative procedures available for this purpose[1]. This method yields highly unreliable estimates when the deflators (price indices of output and inputs) are not very much accurate. A small percentage error in the gross output comes out as much larger percentage error in the real value added (Christopher,1969; Griliches, 1963).

We know, the output structure of the paper industry is very much heterogeneous. There are hundreds of varieties of paper and paperboard which create difficulty in construction of a single price index to deflate the gross ouput of the industry. It might be that price index that we have used for this purpose, is not very precise. This might be resulting in a deflation bias in the real value added and thus inconsistent regression fits. The deflation of the

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1. The Double-Deflation Method for value added can be expressed as:

V_{deflt}=(Gross Output)$_{deflt}$-(Gross Material Input)$_{deflt}$
subscript 'deflt' means 'deflated'.

wages for which we have used the working class (general) consumer price index series might have also been inaccurate. Further, the multicollinearity among the explanatory variables of Eqs.(5) to (8) seems to be a factor in making their estimates unrealiable. In view of the doubt regarding the accuracy of the deflated variables and unreliability of the regression coefficients arising from the multi-collinearity among the explanatory variables, we discard fit no (5) to (8) altogether at this stage and concentrate on the first four fits in which current variables have been used instead of the deflated one. The use of the undeflated (i.e. current) variables in estimation of the CES production function is a common practice although in time series studies this results in an upward bias in the elasticity of substitution (Nerlove, 1967). Ferguson (1965) for example, in his time series study of the CES production function of the American manufacturing industries used the current value added per unit of labour and current wage rate.

Dropping the insignificant variables V and t from the estimated equations (1) and (2), the revised estimates for them are as follows:

$$(9) \quad \ln \frac{V}{L_p} = -7.26282 + 1.18835 \ln (W_p)$$

$$SE = 0.11$$
$$t = 10.99$$

$$R = 0.946; \qquad F = 119.7; \qquad d = 0.988$$

$$(10)\quad \ln \frac{V}{L_m} = -9.12739 + 1.52035 \ln (W_m)$$

$$SE = 0.16$$
$$t = 9.35$$

$$R = 0.929; \qquad F = 60.3; \qquad d = 1.05$$

Alternatively to reduce the effect of trend, we have taken the value added per unit of labour and money wage rate in terms of first differences of their logs, which gave the following regression equations:

$$(11)\quad \Delta \ln \frac{V}{L_p} = -0.00319 + 1.2662 \,\Delta \ln (W_p)$$

$$SE = 0.361$$
$$t = 3.78$$

$$R = 0.724; \qquad F = 14.33; \qquad d = 2.04$$

$$(12)\quad \Delta \ln \frac{V}{L_m} = 0.0414 + 0.93459 \,\Delta \ln (W_m)$$

$$SE = 0.370$$
$$t = 2.52$$

$$R = 0.573; \qquad F = 6.37; \qquad d = 2.00$$

In the fits shown by equations (9), (10) and (11), the estimates of the elasticity of substitution i.e., the coefficients for logarithms of wage rate (W_p or W_m), are significant at 1% level of the significance but in the last fit (eq. no 12) it is significant at 5% level. In three out of these four fits i.e., in eq (9), (11) and (12) the elasticity of substitution is not significantly different from 1 at 5% level of significance ($(\sigma-1)/SE < (t_{0.05}=1.76)$ for 14 degrees of freedom). Eq (10), in which we have

considered the 'manyears' worked by the workers only as a relevant labour input for the industry, assuming zero contribution of 'persons other than workers', however, yields higher elasticity of substitution (1.5) which is significantly different from 1. This equation may be overlooked since, normally, value added is taken as a function of all persons employed in an industry and not only of the workers alone. Engineers, managers, supervisors, etc., are some important categories of 'non-workers' i.e., persons other than workers, who contribute much to the efficiency of an industry. Hence their exclusion from the CES relationship used to estimate the elasticity of substitution for the Indian paper industry is not justified. Thus, from equations (9) and (11) which we finally accept as the best estimate of the CES relationship, give us almost unitary elasticity of substitution for the Indian paper industry. The elasticity of substitution can be estimated through an alternative procedure. Earlier, while discussing the properties of the CES production function, we have derived the expression for its "substitution function" which equates the relative prices of the factors of production with their relative marginal products. This, we have expressed in mathematical terms as:

$$\frac{w}{r} = \frac{f_L}{f_K} = \left(\frac{1-\delta}{\delta}\right)\left(\frac{K}{L}\right)^{(1+\rho)}$$

where w is the wage rate;

r is the 'price' of capital service;

'δ' and 'ρ' are the "distribution" and "substitution" parameters of the CES production function;

K/L is the capital labour ratio.

This equation can be used to estimate 'ρ' which in turn gives us the estimate for the elasticity of substitution (σ) through the relationship $\sigma = \frac{1}{1+\rho}$. The advantage of using this equation is that it is independent of the "efficiency parameter (γ)", changes in which show the neutral technological progress and therefore, shift of the CES production function. Thus, through this equation, we will get estimate of the elasticity of substitution (σ) net of the neutral technological progress if any. Multiplying both the sides of the equation by $\frac{L}{K}$ we get its simplified version as:

$$\frac{wL}{rK} = \frac{(1-\delta)}{\delta}\left(\frac{K}{L}\right)^{\rho}$$

Where wL is the share of labour in value added and rK is the share of capital in value-added.

Since $rK = V - wL$, so we have,

$$\frac{wL}{V-wL} = \frac{1-\delta}{\delta}\left(\frac{K}{L}\right)^{\rho}$$

Transforming this in logarithmic form:

we get,

$$\ln \frac{wL}{V-wL} = a_o + \rho \ln \left(\frac{K}{L}\right)$$

where $a_o = \ln \left(\frac{1-\delta}{\delta}\right) =$ constant.

For Indian paper industry the fitted version of this equation is as follows:

$$\ln \frac{wL}{V-wL} = -0.52221 + 0.08422 \ln \left(\frac{k}{L}\right)$$

$$SE = 0.125$$
$$t = 0.67^{*}$$

$$R = 0.177^{*} \qquad F = 0.45^{*}$$

* Indicates insignificance at 10% level.

Judged from the R and F ratios, this is totally insignificant relationship. The coefficient (ρ) of $\ln \left(\frac{K}{L}\right)$ is extremely low that too insignificant and, therefore, not different from zero. Thus, zero value for 'ρ' implies unitary elasticity of substitution ($\sigma = 1$) for the Indian paper industry. This supports our earlier estimate of the unitary elasticity of substitution for the industry which we got through the conventional procedure for its measurement.

It may be mentioned here that in most of the studies on the CES production function values of the elasticity of substitution have been found clustering around unity for the paper industry. For example, using an international cross-section of 19 countries Arrow and

others (1961) have found an estimate of 0.965 for it. With the same data but applying a correction for the technological differences among the countries Fuchs (1963) got a value of 0.912 for it. In a different study Ferguson (1965) has found almost unitary elasticity of substitution for the U.S. paper industry. For Indian paper industry using the cross-sectional data, Dadi (1970) got an estimate of 1.28 for the elasticity substitution. Similarly, using a cluster of time series and cross-sectional data Ulganathan (1970) got 0.912 as the final estimate of the elasticity of substitution for this industry. All these estimates like ours, are not significantly different from unity which is the Cobb-Douglas specification for the elasticity of substitution. It follows that the Cobb-Douglas specification of the production function may be taken empirically valid for the Indian paper industry. In the next section we will, therefore, go through its specification and estimation for the industry in order to measure the contribution of different factors of production to output and hence of the 'degree of returns to scale' through an alternative procedure.

5.5 Specification and Estimation of the Cobb-Douglas Production Function for Indian Paper Industry:

The VES and CES production functions with which

we were dealing so far are limited to two factors of production, viz. capital and labour only. This is because their specification and estimation with more than two factors of production is very difficult if not impossible (Uzawa, 1962; Mukerji, 1964-65). The Cobb-Douglas production function is free from such limitation. It can be specified with any number of possible inputs used in production. Normally, in empirical estimation of the Cobb-Douglas production function for a commodity, the inputs used in its production are grouped together in four distinct categories, namely, (1) capital (K); (2) Labour (L); (3) fuel and power (F) and (4) materials (M). With these categories of inputs, the Cobb-Douglas production function can be specified as:

$$P = A\, K^{\alpha_1} L^{\alpha_2} F^{\alpha_3} M^{\alpha_4} u. \qquad (12)$$

Where P is the quantity of output; A, $\alpha_1, \alpha_2, \alpha_3$ & α_4 are positive constants. 'A' may be called as the 'efficiency' coefficient like in the CES production function. A change in 'A' other things remaining the same, indicates the 'neutral' shift of the production function. $\alpha_1, \alpha_2, \alpha_3$ & α_4 are the elasticities of output (P) with respect to capital (K), labour (L), fuel and power (F) and materials (M) respectively. u is the random error term. This production function when transformed in the logarithmic

form and fitted to the data with the use of the least square procedure may give unreliable estimates of the coefficients 'A', $\alpha_1, \alpha_2, \alpha_3$ and α_4, because the explanatory variables K,L,F and M are not truely independent of each other. In an industry, consumption of materials depends upon the services of capital and labour inputs. Similarly, consumption of fuel and power depends upon the services of plant and machinery which is a part of the capital input. More specifically, we may write the consumption function for aggregate material input (M) and aggregate fuel and power as follows:

$$M = f\ (K,L) \tag{13}$$

$$F = f\ (K) \tag{14}$$

These are technical relations dealing with the aggregates so the question of including the price variable in each of them does not arise. If K = 0, L = 0, consumption of fuel and power and materials must also be zero since there is no evidence of the use of these materials independent of capital and labour inputs, This implies that the constant term in the formal relationships (13) and (14), whether they are linear or nonlinear, should be zero on theoretical ground. For Indian paper industry, we have fitted both of these relationships using the deflated time series data. The resulting regression fits

are as follows:

(i) $$M = -203.0557 + 0.13246\,K + 0.03107\,L_m$$
$$(3.33) \qquad (2.02)$$
$$R = 0.995; \quad F = 609.9; \quad d = 2.32$$

(ii) $$\ln M = -2.34025 + 0.68218 \ln (K) + 0.36131 \ln (L_m)$$
$$(4.88) \qquad (2.42)$$
$$R = 0.992; \quad F = 396.2; \quad d = 1.94$$

(iii) $$F = 55.89291 + 0.03824\,K$$
$$(25.1)$$
$$R = 0.989; \quad F = 630.7; \quad d = 1.40$$

(iv) $$\ln F = -1.56283 + 0.83262 \ln (K);$$
$$(26.7)$$
$$R = 0.991; \quad F = 714.7; \quad d = 2.10$$

where M is the deflated value of materials consumed by the industry (Rs. Lakhs)

F is the deflated value of fuel and power consumed by the industry (Rs. Lakhs)

K is the deflated net book value of capital (Rs. Lakhs)

L_m is number of manyears worked (=8x300 manhours)

Judged on the basis of the correlation coefficient (R) and F-ratio, all these fits are highly significant at 5% level of significance. The correlation coefficients in the linear

and log fits vary between 0.989 to 0.995. Thus, taking into consideration these strong relationships among the explanatory variables, K,L,M & F of the Cobb-Douglas production function (eq.12), we can drop both M and F from it and retain only the primary factors of production, viz. K and L. The revised specification of the Cobb-Douglas production function can be expressed in mathematical form as:

$$P = A K^{\alpha} L^{\beta} \tag{15}$$

Where 'α' and 'β' can now be interpreted as the 'gross' elasticity of output with respect to the capital and labour inputs respectively. They are 'gross' because they take into account the output elasticities with respect to fuel and power and material inputs also. Materials and fuel which come in the category of 'intermediate' inputs, are automatically dropped out from the Cobb-Douglas production function if output is taken in terms of value added, that is:

$$V = A K^{\alpha} L^{\beta} \tag{16}$$

Although the practice of taking value-added as the output variable is widespread, but in this case the concept of production function which is a physical relationship, is lost and it may be interpreted as a 'distribution function' (Ferguson, 1963; Lave, 1966). However, whether we call it as a production function or

distribution function, it is an important relationship for empirical analysis. We will, therefore, estimate it for the industry along with the one expressed by equation (15).

In the preliminary round, the following variants of equation (15) have been estimated using the timeseries data of the Indian paper industry covering the period 1949-1964.

$$P = A\, e^{gt}\, K^{\alpha_1}\, L^{\beta_1}\, u. \quad \text{(i)}$$

$$P = A\, e^{gt}\, K^{\alpha_2}\, L^{\beta_2}\, u. \quad \text{(ii)}$$

The new variable e^{gt} in these equations, has been included to test for the technological progress which is assumed to be increasing exponentially at the rate of 'g' over time in the industry. In the first equation the labour variable (L_p) takes into account all persons (workers + persons other than workers) employed in the industry, while in the second equation L_m represents only workers that too in terms of 'manyears' worked (1 man year = 8x300 manhours, assuming 8 hours working day and 300 days in a 'year') assuming the services of nonworkers i.e. the 'persons other than workers' as a non-production labour input used in the industry. Although in the previous section we have rejected L_m in favour of L_p to measure the elasticity of substitution, yet we are

using it in this section to see how this affects the parameters of the Cobb-Douglas production function. Both the equations have been fitted with two alternative capital series, K_1 and K_2. K_1 represents the deflated book value of fixed capital. This is based on the assumption of constant proportionality between 'book value' and 'current value' of the fixed capital (Ref: Ch.2, page). K_2 represents the deflated 'current value' of the fixed capital. The familiar 'perpetual inventory' method has been used to construct this series. Details regarding these two capital series and other data for production function are given in Chapter 2. For both the equations the regression fits in logarithmic form are as follows:

Variables: P: Deflated value of output (Paper and paperboard, pulp and paperproducts (Rs. Lakhs)

K_1 & K_2: Deflated fixed capital as defined above (Rs. Lakhs)

L_p & L_m: No. of persons employed and no. of 'manyears' worked by workers in the industry respectively.

t: Calender time 1949 = 1, 1950 = 2 and so on.

$$(1a)\ \ln(p) = 3.96280 + \underset{(2.12)}{0.50741} \ln(K_1) - \underset{(-0.292)}{0.08577^{*}} \ln(L_p) + \underset{(2.94)}{0.08232}\, t$$

$R = 0.995$; $F = 404.71$; $d = 2.15$

1(b) $\ln(p) = 3.19633 + 0.53187 \ln(K_2) - 0.03733 \ln(L\ ) + 0.07077(t)$

$$(2.61) \qquad (-0.11)^{*} \qquad (2.56)$$

$R = 0.996$; $F = 460.9$; $d = 2.22$

2(a) $\ln(p) = 1.64893 + 0.18083 \ln(K_1) + 0.40333 \ln(L_m) + 0.09330\ t$

$$(0.81)^{*} \qquad (1.905) \qquad (3.69)$$

$R = 0.996$; $F = 524.65$; $d = 1.86$

2(b) $\ln(p) = 1.29384 + 0.30158 \ln(K_2) + 0.34703 \ln(L_m) + 0.0777\ (t)$

$$(1.55^{*}) \qquad (1.88) \qquad (3.18)$$

$R = 0.995$; $F = 598.5$; $d = 2.14$

In all these four fits, coefficients marked with asterisk (*) are insignificant at 5% level of significance with 12 degrees of freedom. The coefficient which are significance at this level are highly unreliable because of the high degree of multicollinearity among the explanatory variables, especially between capital and trend variables. The extent of correlation among different pairs of explanatory variables can be seen in the following table.

Correlation Coefficients

	$\ln K_1$	$\ln K_2$	$\ln L_p$	$\ln L_m$	t	$\ln P$
$\ln K_1$	1.000	-	0.982	0.973	0.988	0.992
$\ln K_2$	-	1.000	0.978	0.969	0.989	0.993
$\ln L_p$			1.00	-	0.970	0.972
$\ln L_m$				1.000	0.953	0.971
t					1.000	0.993

Alternatively, to remove the effect of multicollinearity, we have estimated a set of four new equations in which variables have been taken in terms of first differences of their logs. Specifically the equations that we have fitted to data, following this approach, can be expressed as:

$$\text{(iii)} \quad \left[\ln(P)_{t+1} - \ln(p)_t\right] = \gamma + \alpha\left[\ln(K)_{t+1} - \ln(K)_t\right] + \beta\left[\ln(L_p)_{t+1} - \ln(L_p)_t\right]$$

$$\text{(iv)} \quad \left[\ln(P)_{t+1} - \ln(P)_t\right] = \gamma + \alpha\left[\ln(K)_{t+1} - \ln(K)_t\right] + \beta\left[\ln(L_m)_{t+1} - \ln(L_m)_t\right]$$

The fitted versions of those two equations are as follows:

3(a) $$\triangle\ln(P)_t = 0.12691 + \underset{(0.40^{*})}{0.09326}\triangle\ln(K_1)_t + \underset{(0.21^{*})}{0.05990}\triangle\ln(L_p)_t$$

$$R = 0.175; \quad F = 0.191^{*}; \quad d = 2.53$$

3(b) $$\triangle\ln(P)_t = 0.1137 + \underset{(0.76^{*})}{0.18619}\triangle\ln(K_2)_t + \underset{(0.06^{*})}{0.01765}\ln(L_p)_t$$

$$R = 0.252; \quad F = 0.406^{*}; \quad d = 2.57;$$

4(a) $$\triangle\ln(P)_t = 0.1176 + \underset{(0.13^{*})}{0.02612}\triangle\ln(K_1)_t + \underset{(1.615)}{0.42109}\triangle\ln(L_m)_t$$

$$R = 0.448; \quad F = 1.51^{*}; \quad d = 2.77;$$

4(b) $$\triangle\ln(P)_t = 0.1075 + \underset{(0.46^{*})}{0.09575}\triangle\ln(K_2)_t + \underset{(1.515)}{0.39423}\triangle\ln(L_m)_t$$

$$R = 0.462; \quad F = 1.629^{*}; \quad d = 2.80;$$

As shown by the F ratios, all these fits are highly insignificant. Therefore, we cannot conclude anything from them. This is, however, not very surprising. As we know experiments with first differences can give satisfactory results only if data series are accurate. Errors in data got magnified when first differences are taken. As already mentioned in chapter 2, the data that we have got may have errors. In view of the inconsistent estimates, we reject this set of equations altogether in favour of the previous one in which all four equations are significant, although unreliable, because of the multicollinearity, among their explanatory variables. In this set of regression fits, we found very high degree of correlation between the capital stock (K_1 or K_2) and progress factor (e^{gt}). This implies that technological progress which is assumed to be neutral, increasing exponentially at the rate of 'g' overtime, was not independent of the changes in the capital input of the industry. In other words there might have been capital-embodied technological progress in the industry. It was quite possible since as Solow (1960) points out: "improvements in technology affect output only to the extent that they are carried into practice either by net capital formation or by the replacement of old fashioned equipment by the latest models...". Taking this possibility into consideration we have dropped the progress factor (e^{gt}) from equations

(i) and (ii) shown above. The revised estimates of the Cobb-Douglas production function with capital and labour as the sole explanatory variables are as follows:

5(a) $\ln(P) = -2.12972+0.60276 \ln(K_1) + 0.48271 \ln(L_p)$

$$(2.84) \qquad (1.22)^{*}$$

$R = 0.992$; $F = 376.53$; $d = 2.58$

5(b) $\ln(P) = -2.17179+0.56297 \ln(K_2) + 0.51472 \ln(L_p)$

$$(3.54) \qquad (1.66)$$

$R = 0.993$; $F = 458.15$ $d = 2.29$

6(a) $\ln(P) = -1.31759+0.67239 \ln(K_1) + 0.35128 \ln(L_m)$

$$(4.88) \qquad (1.38$$

$R = 0.992$; $F = 388.08$; $d = 2.48$

6(b) $\ln(P) = -1.30841+0.63152 \ln(K_2) + 0.37900 \ln(L_m)$

$$(5.53) \qquad (1.74)$$

$R = 0.993$; $F = 466.3$; $d = 2.29$

If output variable is taken in quantity term rather than in value term, we get the following estimates of the Cobb-Douglas production function for the industry:

7(a) $\ln(P') = -4.93101+0.57230 \ln(K_1)+0.53663 \ln(L_p)$

$$(2.75) \qquad (1.38)$$

$R = 0.992$; $F = 391.54$; $d = 2.01$

7(b) $\ln(P') = -4.9429+0.5363\ \ln(K_2)+0.56404\ \ln(L_p)$

(3.50) (1.89)

$R = 0.993$; $F = 482.18$; $d = 2.06$;

8(a) $\ln(P') = -3.69487+0.68053\ \ln(K_1)+0.33224\ \ln(L_m)$;

(4.94) (1.31)*

$R = 0.992$; $F = 386.37$; $d = 1.73$

8(b) $\ln(P') = -3.74499+0.63272\ \ln(K_2)+0.37156\ \ln(L_m)$;

(5.64) (1.72)

$R = 0.993$; $F = 464.41$; $d = 1.80$

All these fits are statistically highly significant since their F ratios exceed the minimum significant limit even at 0.005% level of significance. They show very high degree of multiple correlation (R) and are free from the autocorrelation bias ($d > d_u$ or $(4-d_u)$ at 5% level of significance with $K' = 2$, $n = 16$). In these fits values of the capital coefficient (α) are significant at 5% level and vary between 0.536 to 0.681. The coefficients for labour (L_p or L_m) are insignificant in all fits except in Eq 6(b) at 5% level. At 10% level, however, only two (t-ratios of which are marked with asterisk (*)) out of 8 labour coefficients are insignificant. The existence of a very high degree of correlation (0.97 to 0.98) between capital and labour variables which violates the assumpition of least square procedure used in estimation

of the fits, seems to be the main reason for insignificant labour coefficients.

In all these fits (equations 5(a) to 8(b)) the sum of capital and labour coefficients ($\alpha+\beta$) clusters around unity. The maximum departure of the sum of α & β ~~and~~ can be seen in equations 7(a) and 7(b) where it is 1.10 but not significantly different from 1.0. The unitary sum of α and β implies constant returns to scale prevailing in the industry during the period under study. This is the main conclusion that we have got from the estimates of the Cobb-Douglas production functions shown above. In the previous section while dealing with the CES production function we have reached similar conclusion. Once we have reached this conclusion, the regression estimates of the Cobb-Douglas production function for the industry can be modified further by taking the output and capital variables in terms of per labour unit. This reduces the unreliabily of capital and labour coefficients arising out of the multicollinearity between the capital and labour variables in the regression fits. In mathematical form the Cobb-Douglas production function can be specified as:

$$P = A K^{\alpha} L^{1-\alpha} u$$

Dividing both the sides of this equation by L we get;

$$\frac{P}{L} = A\left(\frac{K}{L}\right)^{\alpha} u \tag{17}$$

Estimates of this equation with alternative capital and labour series for the Indian paper industry are as follows;

9(a) $\ln\left(\frac{P}{L_p}\right) = 0.33233 + 0.69368 \ln\left(\frac{K_1}{L_p}\right)$
(10.89)

$R = 0.946$; $F = 118.75$; $d = 2.29$

β = Coeff. of Labour $(L_p) = 1-\alpha = 0.30635$

9(b) $\ln\left(\frac{P}{L_m}\right) = 0.36529 + 0.69579 \ln\left(\frac{K_1}{L_m}\right)$
(11.38)

$R = 0.950$; $F = 129.58$; $d = 1.975$

β = Coeff. of Labour $(L_m) = 1-\alpha = 0.30421$

10(a) $\ln\left(\frac{P}{L_p}\right) = 0.43278 + 0.63722 \ln\left(\frac{K_2}{L_p}\right)$
(12.11)

$R = 0.955$; $F = 146.55$; $d = 2.18$;

β = Coeff. of Labour $(L_p) = 1-\alpha = 0.36278$

10(b) $\ln\left(\frac{P}{L_m}\right) = 0.46775 + 0.64099 \ln\left(\frac{K_2}{L_m}\right)$
(12.59)

$R = 0.959$; $F = 158.45$; $d = 1.653$;

β = Coeff. of Labour $(L_m) = 1-\alpha = 0.35901$

Statistically all these fits and their coefficients are highly significant and there is no evidence of the autocorrelation in any of them since $d > d$ or $(4-d) = 1.24$'

at 5% level with one explanatoryvvariable and 16 observations. For each capital series (K_1 and K_2) we find virtually the same value of the α coefficient in the regression fits with alternative labour inputs (L_p or L_m). The estimates of α with K_1 capital series are higher in magnitude than those with K_2 capital series. We recall that K_1 represents deflated book value of fixed capital which is based on assumption of some constant proportionality between book-value and current value of the fixed capital. This assumption may not be true at all. K_2 series on the other hand represents deflated current value of the fixed capital used in production in the industry. This has been constructed with the application of the perpetual inventory method. It is, therefore, supposed to be more reliable than K_1. Hence, among the regression fits shown above, we prefer equations 10(a) and 10(b) which have been fitted with K_2 capital series. Since both these fits have same value for α coefficient, for simplicity we may, therefore, prefer eq. 10(a) in which all persons employed in the industry (L_p) constitute the labour input. This is in conformity with our earlier stand regarding the labour input (See page 293). So the best estimate of the Cobb-Douglas production function for the Indian paper industry can be expressed in standard form as:

$$\text{(11)} \quad P = 1.54156 K_2^{0.63722} L_p^{0.36278}$$

$$R = 0.955; \qquad F = 146.55; \qquad d = 2.18$$

In this production function we have taken the gross output (P) as a function of the capital (K) and labour (L_p) inputs assuming no independent role of the material input in its variation. The gross output is equivalent to the 'value added' plus the 'materials use value of the output' that is to say the 'output equivalent to the material input'. During the period 1949-1964 the average relative share of labour in the gross value added (deflated) by the Indian paper industry (i.e. wages and salaries etc., per unit of value added) was 0.358 (Ref: Table 5.3). The remaining part of the unit value added (0.642) may be taken as the average relative share of capital although it includes profit also, but to account for this we have not taken any separate variable in this study. For relative shares of capital and labour in the 'materials use' value of the output', we do not have any direct estimates as in the case of the value added. In fact this is not possible. Indirectly, we may taken them approximately equal to the demand elasticities for materials with respect to the capital and labour inputs respectively. For the paper industry of India, we have found these elasticities in the order of 0.682 and 0.361 for the two inputs respectively. (Ref: Eq. ii Page 299) The proportion of these elasticities (0.682:0.361) is not significantly different from the proportion of the relative shares of capital and labour in the gross value added

by the industry (0.642:0.358). This implies that in the gross value added as well as in the materials use value of the output, the relative shares of capital and labour inputs of the industry were, almost in the same proportion clustering roughly around 0.65:0.35 during the period under review. Since, both the gross value added and 'materials use' value of the output, are parts of the gross output, we can, therefore, take 0.65:0.35 as the proportion of the average gross output attributed to the capital and labour inputs respectively in the paper industry of India during the period 1949-64. The fitted Cobb-Douglas production function expressed by eq. 11 also gives us almost the same proportion (0.64:0.36) of the gross output attributed to the capital and labour inputs respectively in the industry. This result reveals that during the period 1949-64 the competitive equilibrium conditions were prevailing in the paper industry of India, because, only under such conditions the output elasticity of a factor of production given by the Cobb-Douglas production function becomes equal to the relative output share of that factor. Thus, the reliability of the fitted Cobb-Douglas production function shown by eq.(11) for the Indian paper industry seems to be fairly good.

As we have said earlier, estimation of the Cobb-Douglas production function with value added as the output

variable is a common practice. Following this convention we have made a few more estimates of the Cobb-Douglas production function for the Indian paper industry using the finally choosen set of the explanatory variables (K_2 and L_p) and the value-added series. Such fits are as follows:

12(a) $\ln V = -5.61307+0.35442 \ln(K_2)+0.93264 \ln(L_p)$

$$\begin{array}{cc} SE = 0.25 & SE = 0.5 \\ t = 1.37 & t = 1.85 \end{array}$$

$R = 0.982$; $F = 175.88$; $d = 1.67$

12(b) $\ln \left(\frac{V}{L_p}\right) = -0.45499+0.62933 \ln \left(\frac{K_2}{L_p}\right)$

$$\begin{array}{c} SE = 0.088 \\ t = 7.09 \end{array}$$

(β = Coeff. of Labour = $1-\alpha$ =037067)

$R = 0.884$; $F = 50.28$; $d = 1.97$

Eq. 12(a) gives highly unreliable estimates of the coefficients for both the explanatory variables. In this equation capital series shows higher degree of correlation with the labour series (r_{KL}=0.98) than with the value added series (r_{KV}=0.97) resulting in the multicollinearity bias and hence unreliable regression coefficients. This equation may, therefore, be discarded. Eq.12(b) gives almost same estimate of α (i.e, of capital coefficient) as we have got earlier in the fit with the

gross output series (Ref:Eq.10(b)).

In the previous section while dealing with the CES production function, we have mentioned some doubts regarding the correctness of the deflated value added series which we have used to fit the Cobb-Douglas production function shown above. For experiment, we have, therefore, estimated two more equations in which undeflated value-added and capital series have been used. These are as follows:

13(a) $\ln V^* = -1.35026 + 0.65349 \ln K_2^* + 0.38286 \ln L_p$

SE = 0.21 SE = 0.64
t = 3.00 t = 0.599

R = 0.985; F = 216.42; d = 2.00;

13(b) $\ln \left(\frac{V^*}{L_p}\right) = -.026340 + 0.60384 \ln \left(\frac{K_2^*}{L_p}\right)$

SE = 0.065
t = 9.18

R = 0.926; F = 84.28; d = 2.8;

β = Coeff. of labour = $1-\alpha$ = 0.3962

(* shows undeflated variables)

Although the use of undeflated variables in fitting the production function is not valid on theoretical grounds because they are not free from the variations in their prices, nevertheless, we have got fairly consistent estimates α and β from them for the Indian paper industry as we have got earlier from the deflated variables. This

may be because of the price control for the products of the industry. Eq. 13(b), however, gives slightly lower estimate of the capital coefficient i.e., α=0.6038, as compared with α =0.63722 found earlier from eq.(11). But the difference between them is not significant on statistical grounds. Thus, using the gross output and value-added series, we have got almost similar estimates of the Cobb-Douglas production function for the Indian paper industry. Eq.(11), shown above, therefore, still remains as the best estimate of the Cobb-Douglas production function for the Indian paper industry which gives us the capital and labour elasticities of output as 0.63722 and 0.36278 respectively. The estimated output and residuals left 'unexplained' by this equation are shown in Table 5.1. As the table shows, the residuals are fairly random in nature. In magnitude, they are smaller than 8% of actual output for all the years except the year 1950 for which the percentage of residual is considerably high (-12.3). Probably, some measurement error in the data might have caused this much negative residual, otherwise, we do not find any specific reason for the low output of paper and paperboard in the year 1950. On the whole we have fairly low residuals. Eq. 11 is, therefore, a good estimate of the Cobb-Douglas production functions for the Indian paper industry.

Table 5.1

Regression Residuals from Eq. 11

Year	Actual output per person (Rs,000)	Estimated Output per person (Rs,000)	Residuals left un-explained (Rs,000)	Residuals as % of Actual output
1949	6.422	5.960	0.462	7.2
1950	6.851	7.692	-0.841	-12.3
1951	7.881	8.178	-0.297	-3.8
1952	9.069	8.359	0.710	7.8
1953	8.506	8.783	-0.277	-3.2
1954	7.558	8.088	-0.530	-7.0
1955	9.447	8.745	0.702	7.4
1956	9.855	9.078	0.777	7.9
1957	10.041	9.708	0.333	3.3
1958	9.760	10.025	-0.265	-2.7
1959	11.263	11.471	-0.208	-1.8
1960	11.710	11.606	0.104	0.9
1961	12.877	11.889	0.988	7.7
1962	12.220	12.923	-0.703	-5.8
1963	13.203	13.504	-0.301	-2.3
1964	14.554	14.354	0.200	1.4

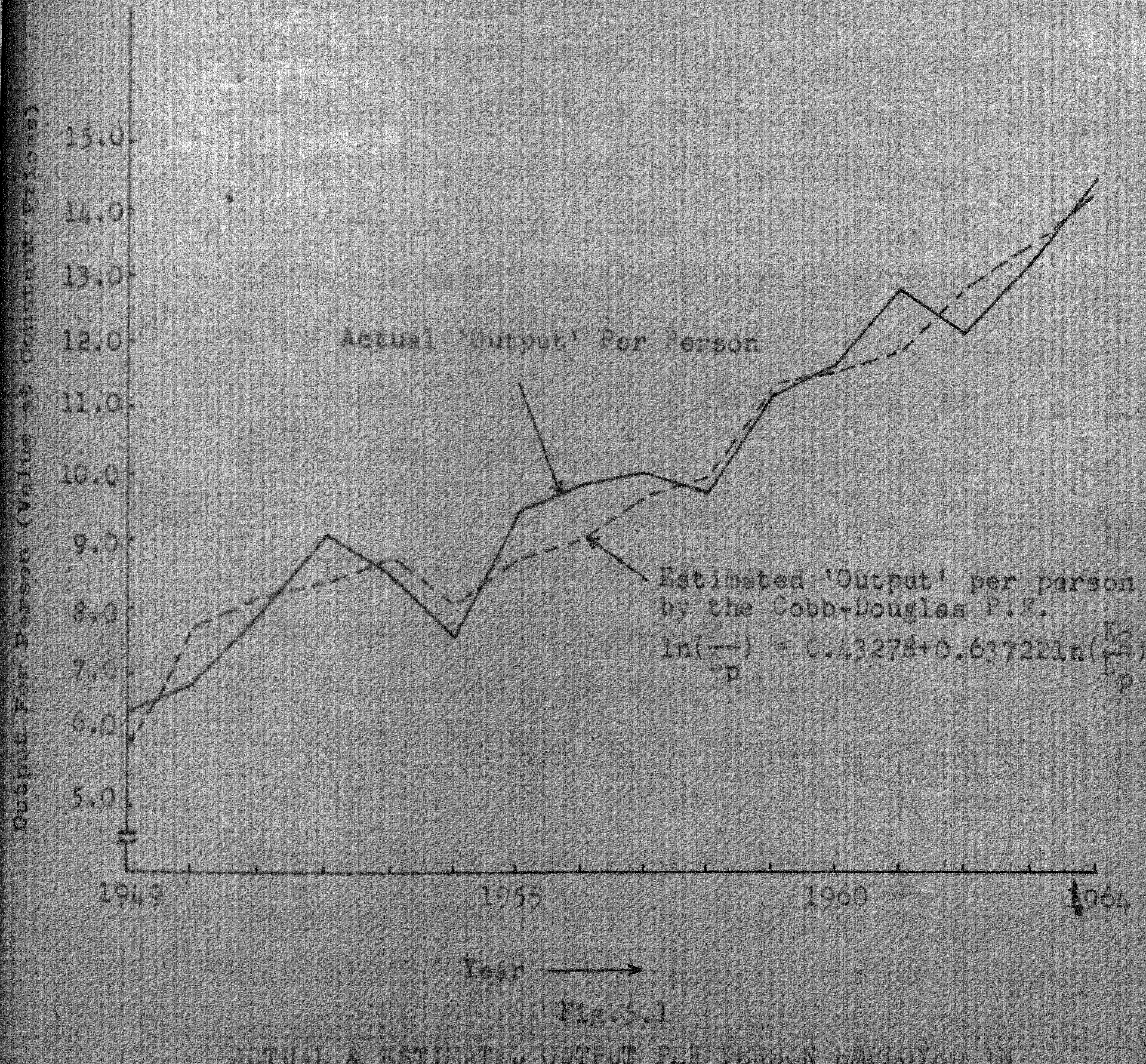

Fig.5.1

ACTUAL & ESTIMATED OUTPUT PER PERSON EMPLOYED IN THE INDIAN PAPER INDUSTRY

5.6 Measurement of 'Neutral' Technological Progress in the Paper Industry of India by Solow's Method:

The term 'technological change' is used to denote a variety of changes in the activities related with the production of a commodity. In terms of one framework it includes the productivity benefits of increased education and skill attainment; of improved health; of improved design and product innovation; of improvements in organization and managerial efficiency and so on (Denison, 1962). In brief, the phrase 'technical change' is used as a shorthand expression for any kind of shift in the production function (Solow, 1957, p.312). If the shifts in the production function are parallel, we call it as the effect of "neutral" technological progress. On the other hand if the shifts are not parallel, we call it as the effect of 'non-neutral technological progress. Technological progress is 'neutral' as Hicks called it if, and only if, the output elasticity of capital and hence the output elasticity of labour, remains constant. By extension, technological progress is 'non-neutral' i.e., 'capital using' or 'labour using' accordingly as the output elasticity of capital increases or decreases. Since, in the Cobb-Douglas production function, the output elasticity of a factor equals its relative share, we can therefore, say

that technological progress is 'neutral' or 'nonneutral' if relative share of capital in output remains unchanged or not. A third way to define 'neutral' and 'nonneutral' technological progress is that in the case of neutral technological progress the marginal rate of substitution between capital and labour, remains constant, while in the case of 'nonneutral' technological progress it no longer remains constant.[1]

Assuming the exponential growth of the neutral technological progress in the paper industry of India over time, we have included the time trend as an explanatory variable for this in the specification of the Cobb-Douglas production function for the industry which we have described earlier. On estimation of the production function for the industry, however, we have got negative conclusion regarding the neutral technological progress in it. In this section we have made an alternative test for the neutral technological progress in the industry using the Solow's method (Solow,1957). There are some other methods devised for measuring the neutral

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1. The following are some important sources which elaborate the concept of neutral and nonneutral technological progress.

   (a) Hicks (1963); Harrod (1956); Ferguson (1969); Brown (1966); Ølgaard (1966); Halm & Mathews (1964); Lave (1966).

technological progress in an industry (Abramovitz 1956; Kendrick 1961; Salter 1960) but we have not used them in this analysis since they are in no way better than the Solow's procedure. A brief outline of the Solow's procedure and the results obtained from this for the Indian paper industry are as follows:

As mentioned earlier, the parameter 'A' of the Cobb-Douglas production function expressed by Eq. 12 on page 317, can be used as a measure of the level of technology. At a point of time this parameter shows constant technology and hence stationary production function. But if it changes over time, this indicates changes in the technology and hence shift of the production function. This shift may be parallel showing the neutral technological progress if the scales of measurement of all other variables of the production function and their output elasticities remain constant. Solow used this property of the production function in derivation of a growth equation as follows:

Let $P_t = A(t)\ f\ (K_t, L_t)$

or explicitly, $P_t = A_t\ K_t^{\alpha}\ L_t^{\beta}$, in this A_t is now a variable showing the neutral technological progress. α & β are constants as defined earlier. Converting this function in logarithms and differentiating with respect to time (t)

we get:

$$\frac{dP_t}{dt}/P_t = \frac{dA_t}{dt}/A_t + \alpha\frac{dK_t}{dt}/K_t + \beta\frac{dL_t}{dt}/L_t$$

If α and β are taken as the relative shares of capital and labour in the value-added (assuming competitive equilibrium conditions) and the time derivatives of variables $\frac{dP_t}{dt}$; $\frac{dA_t}{dt}$; $\frac{dK_t}{dt}$ & $\frac{dL_t}{dt}$ are taken as first differences in their values between two adjacent periods, the above growth equation can be expressed in discrete form as:

$$\frac{\Delta P_t}{P_t} = \frac{\Delta A_t}{A_t} + W_k\frac{\Delta K_t}{K_t} + W_L\frac{\Delta L_t}{L_t} \tag{17}$$

Where W_k = Relative share of capital in value added

W_L = Relative share of labour in value added.

For constant returns to scale, we have

$W_k + W_L = 1$

Therefore, the equation (17) can be modified as:

$$\frac{\Delta p_t}{p_t} = \frac{\Delta A_t}{A_t} + W_k\frac{\Delta k_t}{k_t} \tag{18}$$

Where $\frac{P_t}{L_t} = p_t$ i.e. the output per unit of labour;

and $\frac{K_t}{L_t} = k_t$ i.e. the capital per unit of labour.

Using the time series data on p_t and k_t and alternative approximation for W_k, we got two different estimates of the proportional changes in technology $\left(\frac{\Delta A_t}{A_t}\right)$ series for the Indian paper industry. For first series, we have used the current values of capital share in value added for different years. This series is given in column (7) of Table 5.2. For second series, we have used the base year i.e. 1949 value of capital share for all years covered in this analysis. This is shown in column (9) of the table. The time series of technology A(t) shown in columns (8) and (10) of the table have been computed using the relationship:

$A(t+1) = A(t) \left[1 + \Delta A(t)/A(t)\right]$ with arbitrarily setting the base year (1949) $A(t) = 1.00$.

From the table and graph 5.2(A), we find both the measures of $\frac{\Delta A_t}{A_t}$ series fluctuating around zero line. Similarly, the A(t) series shown in graph 5.2(B) show a fluctuating trend very close of the constant technology line. For most of the years, the A(t) curves take the course below the constant technology line. Probably, this is the effect of too much lower value of A(t) for the year 1950. The dotted curve in graph 5.2(B) represents A(t) series based on 1949 value of capital share. From 1955 onwards, this curve lies above the A(t) curve which is

based on the current values of capital share (W_k). It is quite natural since during this period, on account of growing capital intensity in the industry, relative share (W_k) of capital was considerably higher than what it was in 1949. (Ref: Table 5.2) Lower productivity weight (W_{ko}) to the $\frac{\Delta k_t}{k_t}$ series for this period, therefore, implies higher magnitude of 'residuals' which constitute the $\frac{\Delta A_t}{A}$ series.

Both, $\frac{\Delta A_t}{A_t}$ and A(t) series fail to suggest any thing precisely in favour of the neutral technological progress in the paper industry of India. They fluctuate randomly around the lines representing the constant technology. From this, we can only conclude that there was nothing like 'neutral' technological progress in the industry during the period under view. In Domar's (1961) terminology, $\frac{\Delta A_t}{A_t}$ and A(t) series are nothing but the 'residuals' that is, that part of output per man which is left over after increases in capital per man are accounted for. Beside changes in the productivity, observational errors in the data may be a source for these 'residuals'. This seems to be the main reason for the random fluctuations of $\frac{\Delta A_t}{A_t}$ and A(t) series around the constant technology lines for the paper industry of India; otherwise, it is unlikely that the neutral technological progress should show this kind of behaviour. It should be increasing or decreasing or

at least show some definite trends from which some meaningful conclusions can be drawn. From gross output series at current prices and value-added series both at current and constant prices, we have got similar results regarding the technological progress in the paper industry of India as described above.

There are many difficulties with the Solow's procedure. Its theoretical basis, as we know, rests upon a few standard assumptions e.g., the neutrality of the technical progress; constant returns to scale; competitive conditions prevailing in the economy or industry wherever it is used; and no measurement errors in the data. If any one of these assumptions or rather say, conditions is not fulfilled, the Solow's procedure breaks down. Particularly, along with the neutral technological progress there may be some nonneutral technological progress in the longrun. The procedure fails to separate these two types of technological progress from the data. Thus, in the presence of the nonneutral technological progress it becomes very difficult to accept the A(t) series as a true measurement of the neutral technological progress. Apart from this, it is practically difficult to get accurate estimates for the relative output share of capital used along with others in computation of the neutral technological progress series A(t). The estimation of the output share of capital

is, generally, made through guess work or some adhoc assumptions are made for this which result in an element of arbitrariness in the Solow's measure of the neutral technological progress. In our case, for example, we have subtracted the share of labour (wages etc.) from the gross value added (deflated) by the Indian paper industry, taking the remaining part as the share of capital although it includes the residual income i.e., profit also for which we have not taken any separate variable in the derivation of the Solow's procedure. In computation of the technological progress series A(t) for the Indian paper industry, we have used the gross output as well as the gross value added series. The proportion of the gross output attributed to the capital input in the industry has been taken same as the relative share of capital in the gross value added (Ref: Page 311 for explanation). This is only an approximation which might have caused inaccuracy in the technological progress series A(t) for the industry. Thus, in view of the above limitations of the Solow's procedure, we cannot claim that it has given us accurate estimates of the neutral technological progress in the paper industry of India during the period under review (1949 to 1964).

So far we were mainly concerned with the

measurement of the neutral technological progress in the industry. During the period under review, as we have seen in Chapter 3 of this study, the technological structure of the industry has gone under some important changes. The speed of growth of the capital was much faster than the number of the persons employed by the industry. Consequently the capital per unit of labour, that is, the capital intensity was rising in the industry throughout the period under review (Ref: Table 3.4 Ch.3). At the same time the wage rate in the industry was rising but the 'rate of interest' and 'depreciation costs' which together constitute the 'price' of capital services, were more or less constant. Thus, higher growth in the quantity of capital accompanied with the lower growth in its 'price' and lower growth in the number of workers accompanied with the higher growth in the wage rates indicate that the relative shares of capital and labour inputs in the output of the industry were almost constant during the period under review. This contention is supported by the unitary elasticity of substitution which we have estimated earlier for the industry. However, in Table 5.2 along with others, we have presented a series showing the relative share of capital in value-added (deflated) by the industry. This series on the whole indicates a rising trend in the relative share of capital form which one may conclude

that there has been some nonneutral technological progress in the paper industry of India during the period 1949-64. This result is however, very much doubtful because of the following reasons:

(1) As we have mentioned earlier (Ref: Page 290) the deflation of the value added series is highly unreliable and so is of the wage rate series aused to compute the share of labour in the value added. As a result of this, the series showing the relative share of capital is also unreliable.

(2) Even if we take the relative share of capital accurately estimated, we do not find it significantly different from the estimated output elasticity with respect to capital i.e. $\alpha = 0.637$ (Ref: Fit No.11) at 10% level of significance ($\frac{\alpha - W_k}{0.053} < \underset{(0.10\%)}{t} = \pm 1.345$ with 14 degrees of freedom). Thus, on the basis of this, we can say that the relative share of capital was fairly constant during the period 1949-64 and hence, there was no 'non-neutral' technological progress in the paper industry of India during this period.

Although the results on measurement of the technological progress in the paper industry of India, that we have discussed above, are very much crude, nevertheless from them, we get the conclusion that during the period under study (1949-64) the abstract technology

of the industry was fairly constant. In other words, there were no shifts ('neutral' or 'non-neutral') in the industry's production function. Our estimates of the production functions for the industry which we have discussed in this chapter are, therefore, fairly reliable.

5.7 Summary of Results and Conclusions:

The main purpose of this chapter has been to estimate a production function for Indian paper industry and thus to study the four characteristics of the technology embodied in it. For this the VES, the CES and the Cobb-Douglas production functions have been estimated for the industry using the time series data. The main results obtained from them are as follows:

(1) The relationship between value added per unit of labour and wage rate was found to be independent of the capital-output ratio for the paper industry of India. This implies that the elasticity of substitution between capital and labour was constant and not variable, in the industry during the period 1949-1964.

(2) The elasticity of substitution between capital and labour has been found equal to 1.188 which is not significantly different from unity that is, the value of it prescribed by the Cobb-Douglas production function. The

Cobb-Douglas production function can, therefore, be taken empirically valid for the industry.

(3) In most the fits of the CES and Cobb-Douglas production functions the degree of returns to scale has been found to be approximately unity. This implies that constant returns to scale was prevailing in the industry during the period 1949-1964.

(4) The output elasticity coefficients for the capital and labour inputs were found to be in the order of 0.63722 and 0.36278 respectively from the best fit of the Cobb-Douglas production function for the industry.

(5) We do not have any strong evidence of the neutral technological progress in the industry during the period under review from the fitted CES or Cobb-Douglas production functions. The conventional method of taking trend as a progress factor, to estimate the growth of the technology, failed to give significant results in the estimates of the CES and Cobb-Douglas production functions.

(6) The results on measurement of the technological progress by Solow's procedure onverwhelmingly supported the constant technology in the industry during the period 1949-1964. In other words, there were no shifts ('neutral' or 'non-neutral') in the industry's production function during this period.

(7) On the basis of the constant terms in the fitted CES and Cobb-Douglas production function we cannot say any thing regarding the efficiency of the technology in the industry, because they are not dimensionless. They are relevant parameters for the comparison with other such estimates which we do not have.

(8) The best fits of the CES and Cobb-Douglas production functions from which the above results have been drawn are as follows:

(1) $$\frac{V}{L_p} = -7.26282 + 1.18835 \ln(W_p)$$
$$(10.99)$$

$R = 0.946;\quad F = 119.7;\quad d = 0.988;$

(2) $$P = 1.54156\, K^{0.63722}\, L_p^{0.36278}$$

$R = 0.955;\quad F = 146.55;\quad d = 2.18;$

Where V = Gross Value-added (Lakhs)

P = Gross Output (Rs. Lakhs)

K = Capital (Rs. Lakhs)

L_p = No. of Persons Employed in the Industry

W_p = Wage Rate. (Rs,000 per year)

Table 5.2

Measurement of Technological Change in Indian Paper Industries with Solow's Procedure

Year	Capital Stock per Person k_t	Gross Output per person p_t	$\frac{\Delta k_t}{k_t}$	$\frac{\Delta p_t}{p_t}$	% Share of Capital in Value-Added w_k
1	2	3	4	5	6
1949	8.348	6.422	-	-	58.4
1950	12.459	6.851	0.4925	0.0668	56.7
1951	12.080	7.881	-0.0304	0.1540	56.1
1952	12.678	9.069	0.0495	0.1507	63.5
1953	13.907	8.506	0.0969	-0.0621	59.8
1954	12.484	7.558	-0.1023	-0.1115	62.5
1955	14.534	9.447	0.1642	0.2499	63.8
1956	15.022	9.855	0.0336	0.0432	66.4
1957	16.601	10.041	0.1051	0.0189	67.8
1958	17.121	10.610	0.0313	0.0567	70.2
1959	21.309	11.263	0.2446	0.0615	70.0
1960	21.148	11.710	-0.0076	0.0397	69.7
1961	21.817	12.877	0.0316	0.0997	68.2
1962	25.291	12.220	0.1592	-0.0510	66.7
1963	26.291	13.202	0.0395	0.0804	68.3
1964	28.160	14.554	0.0711	0.1024	68.5

(Table 5.2 contd.)

Year	$\Delta A_t/A_t$ With Current Value of Capital	$A(t)$	$\Delta A_t/A_t$ With Base Year (1949) Value of Capital Share	$A(t)$
	7	8	9	10
1949	-	1.0000,	-	1.0000
1950	-0.2124	0.7876	-0.2108	0.7892
1951	0.1711	0.9224	0.1718	0.9248
1952	0.1198	1.0329	0.1218	1.0392
1953	-0.1181	0.9109	-0.1187	0.9158
1954	-0.0516	0.8639	-0.0517	0.8685
1955	0.1452	0.9893	0.1540	1.0022
1956	0.0209	1.0100	0.0236	1.0259
1957	-0.0524	0.9571	-0.0425	0.9823
1958	0.0347	0.9903	0.0384	1.0200
1959	-0.1097	0.8817	-0.0813	0.9371
1960	0.0450	0.9214	0.0441	0.9784
1961	0.0737	0.9893	0.0812	1.0578
1962	-0.1572	0.8338	-0.1440	0.9055
1963	0.0534	0.8773	0.0573	0.9574
1964	0.0489	0.9202	0.0609	1.0157

1. All variables (k_t p_t) & capital share are in deflated form.
2. $\frac{\Delta k_t}{k_t}$ means $\frac{k_{t+1}-k_t}{k_t}$ and similarly for other proportional ratios $\frac{\Delta P_t}{p_t}$ & $\frac{\Delta A_t}{A_t}$.
3. Time series of Technology A(t) have been constructed using the formula: $A(t+1) = A(t)\ (1+\Delta A_t/A_t)$ & setting arbitrarily A(1949)=1.0

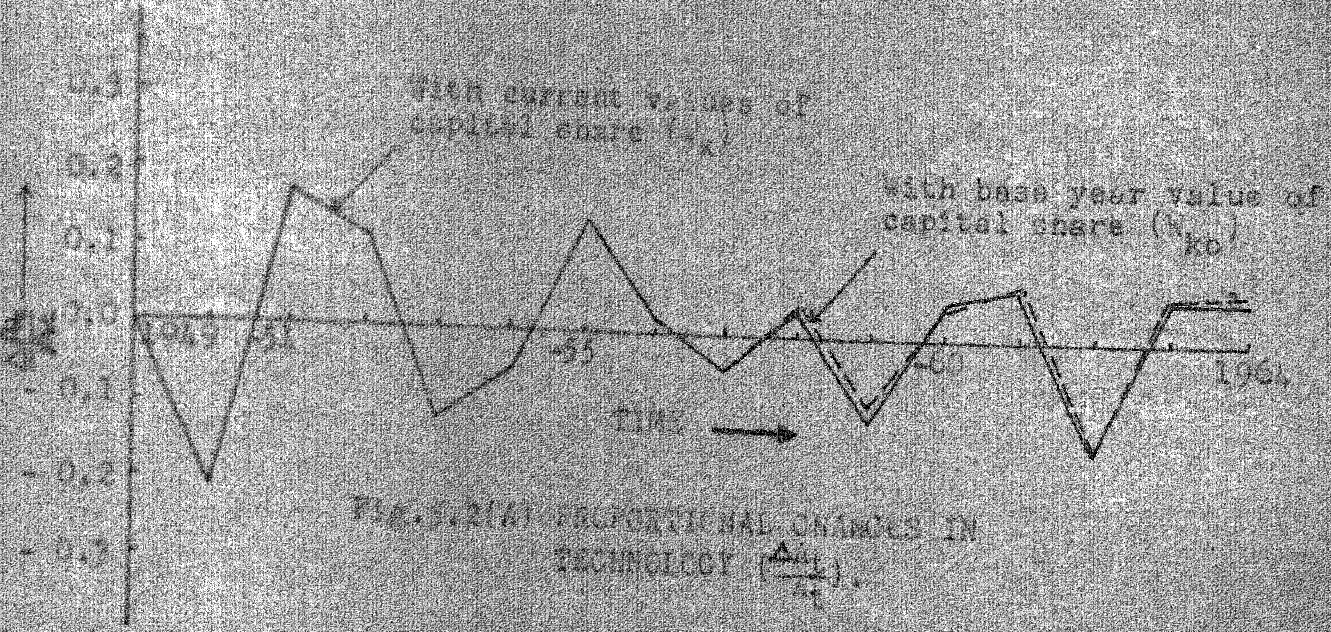

Fig.5.2(A) PROPORTIONAL CHANGES IN TECHNOLOGY ($\frac{\Delta A_t}{A_t}$).

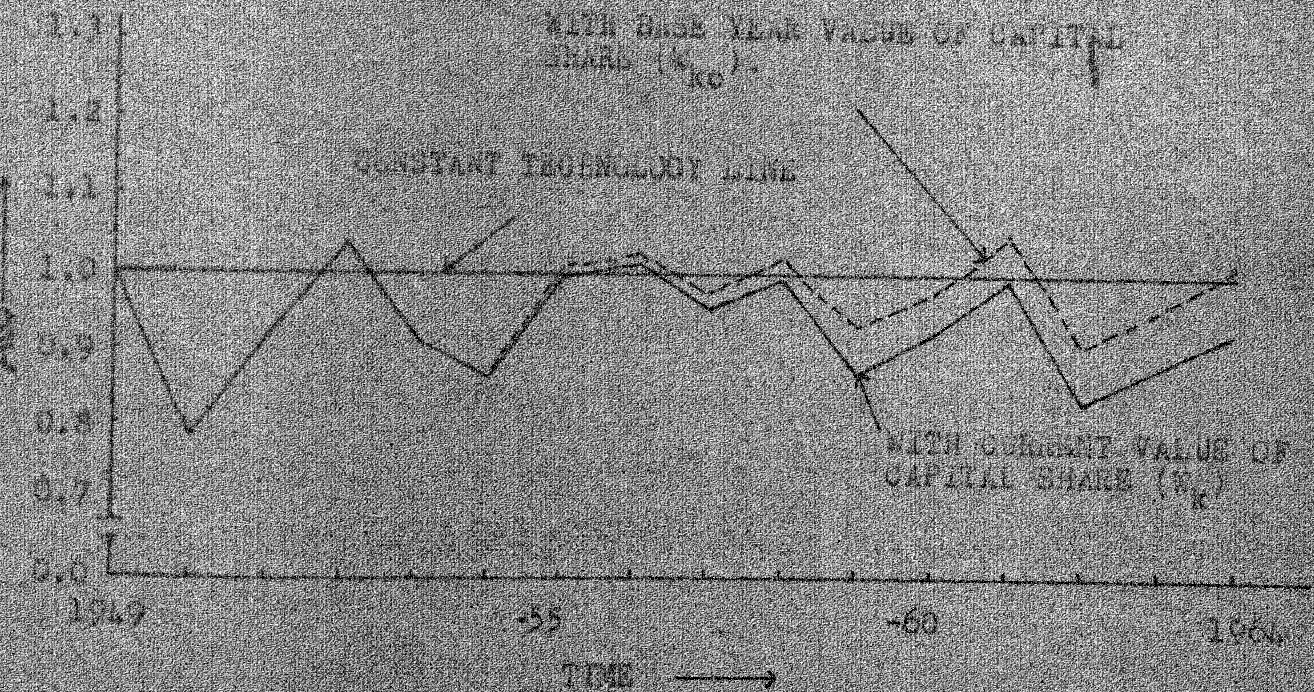

Fig. 5.2(B) TIME SERIES OF TECHNOLOGY(A(t)).

Table 5.3

Data Used in Estimation of Production Functions
(CMI:ASI DATA)

Unit of Value: Rs. Lakhs

Year	Fixed Capital Book Value (K_g)	Fixed Capital Book Value Deflated (K_1)	Fixed Capital Current Value Deflated (K_2)	No. of Persons (L_p)	No. of Workers only (L_w)
1949	1493.76	1713.11	1713.00	20520	18488
1950	2454.81	2769.71	2770.00	22231	19976
1951	2639.28	2603.18	2956.00	21549	19151
1952	2518.19	2517.32	2819.00	19856	17442
1953	3057.44	3058.32	3374.00	21992	19358
1954	3087.00	3163.20	3416.00	25339	21822
1955	3747.91	3922.39	4113.00	26987	23445
1956	4482.34	4494.46	4834.00	29919	25539
1957	5746.52	5546.89	5998.00	33412	28257
1958	5983.11	6139.81	6772.00	35861	30355
1959	8951.25	8257.20	9040.00	38750	32848
1960	11422.90	9932.44	11160.00	46966	40088
1961	11896.12	10113.44	11440.00	46356	40299
1962	15328.04	12659.34	14170.00	50400	43204
1963	18798.82	14738.00	16900.00	56057	47144
1964	22152.06	16582.94	19540.00	58888	48878

contd.

(Table 5.3 contd)

Unit of Value: Rs. Lakhs

Year	No. of Manyears[1] worked by Workers (L_m)	Value of Fuel Powers & Lubricants. Deflated	Value of Materials Deflated	Value of Output (Current)	Value of Output (Deflated)
1949	20021	119.37	574.70	1166.35	1317.71
1950	19648	128.13	589.68	1297.26	1411.85
1951	19578	147.75	752.44	1727.56	1698.38
1952	19078	147.96	742.71	1800.68	1800.48
1953	18373	152.24	856.51	1846.82	1870.62
1954	19951	159.79	860.38	2087.88	2015.21
1955	23115	196.84	1044.33	2525.56	2549.49
1956	25294	244.76	1179.81	2858.97	2948.38
1957	27211	288.42	1346.24	3370.49	3354.82
1958	29287	318.28	1519.49	3688.48	3499.98
1959	35735	382.35	2109.00	5513.51	4364.55
1960	43379	456.64	2366.29	6199.56	5499.78
1961	40411	507.72	2671.18	6820.58	5969.19
1962	44384	518.04	2871.23	7684.88	6158.95
1963	51874	620.78	3305.78	9342.95	7400.77
1964	52751	643.32	3522.58	10296.61	8570.80

1. Manyear = 300 x 8 Manhours.

contd...

(Table 5.3 contd.)

Year	Qty. of Output (000 Tons)	Value Added at Current Price (Rs.Lakhs)	Value Added Deflated (Rs.Lakhs)	Fixed Capital (Undeflated) Per person (Rs.000)	Fixed Capital (Undeflated) Per Manyear worked by workers (Rs.000)
1949	107.39	463.91	519.10	7.280	7.461
1950	115.07	569.97	577.80	11.042	12.494
1951	138.42	785.69	634.00	12.248	13.481
1952	146.73	744.05	744.30	12.682	12.199
1953	152.46	793.90	656.60	13.903	16.641
1954	164.24	906.18	788.10	12.183	15.473
1955	207.78	1182.44	1089.80	13.888	16.214
1956	240.29	1281.42	1270.70	14.982	17.721
1957	273.42	1498.61	1434.10	17.199	21.118
1958	285.10	1863.55	1670.10	16.684	20.429
1959	355.71	2160.82	1508.60	23.100	25.049
1960	457.20	2277.18	2312.20	24.322	26.333
1961	486.49	2447.73	2289.80	25.663	29.438
1962	501.95	2724.79	2228.90	30.413	34.535
1963	603.16	3499.50	2914.80	33.530	36.234
1964	698.52	3881.75	3765.30	37.617	41.994

contd.

(Table 5.3 contd)

Rs.000.

Year	Deflated Book value of Fixed Capital Pers person	Deflated Book Value of Fixed Capital Per M.Y.	Deflated Current Value of F.C. Per Person	Deflated Current Value of F.C. Per Manyear	Output Current Value Per Person
1949	8.348	8.557	8.348	8.556	5.684
1950	12.459	14.097	12.460	14.098	5.835
1951	12.080	13.296	13.718	15.099	8.017
1952	12.678	13.195	14.197	14.776	9.069
1953	13.907	16.646	15.342	18.364	8.398
1954	12.484	15.855	13.481	17.122	8.240
1955	14.534	16.969	15.241	17.794	9.358
1956	15.022	17.769	16.157	19.111	9.556
1957	16.601	20.385	17.952	22.043	10.088
1958	17.121	20.964	18.884	23.123	10.285
1959	21.309	23.107	23.329	25.297	14.228
1960	21.148	22.897	23.762	25.727	13.200
1961	21.817	25.026	24.679	28.309	14.713
1962	25.118	28.522	28.115	31.926	15.248
1963	26.291	28.411	30.148	32.579	16.667
1964	28.161	31.436	33.182	37.042	17.485

contd.

(Table 5.3 contd)

Rs. 000.

Year	Output Deflated Per Person	Output Current Value Per Manyear	Output Deflated Value Per Manyear	Value Added Current Per Person	Value Added Constant Per Person
1949	6.442	5.826	6.582	2.261	2.530
1950	6.851	6.603	7.486	2.565	2.599
1951	7.881	8.824	8.675	3.646	2.936
1952	9.069	9.439	9.439	3.747	3.748
1953	8.506	10.052	10.181	3.610	2.986
1954	7.556	10.465	9.600	3.576	3.110
1955	9.447	10.926	11.030	4.382	4.039
1956	9.855	11.303	11.656	4.300	4.247
1957	10.041	12.386	12.329	4.485	4.297
1958	9.760	12.594	11.951	5.197	4.657
1959	11.263	15.429	12.214	5.576	5.000
1960	11.710	14.292	12.678	4.847	4.923
1961	12.877	16.878	14.771	5.280	4.939
1962	12.220	17.315	13.877	5.406	4.422
1963	12.202	18.011	14.267	6.243	5.199
1964	14.554	19.519	16.248	6.592	6.394

contd...

(Table 5.3 contd.)

Year	Value Added Current Per M.Y (Rs.000)	Value Added Constant Per M.Y. (Rs.000)	Share of Capital in Value Added (Current) %	Share of Capital in Value Added (Constant) %	Total Salary Wages & Benefits of all persons (Rs.Lakhs)
1949	2.317	2.593	49.3	58.4	211.28
1950	2.901	2.941	51.2	56.7	245.16
1951	4.013	3.186	59.5	56.1	283.87
1952	3.900	3.901	58.1	63.5	278.13
1953	4.321	3.529	58.2	59.8	289.61
1954	4.542	3.950	59.6	62.5	323.78
1955	5.115	4.715	65.4	63.8	370.75
1956	5.066	5.024	61.4	66.4	435.43
1957	5.507	5.270	61.5	67.8	495.45
1958	6.363	5.703	65.6	70.2	556.00
1959	6.047	5.620	59.3	70.0	698.22
1960	5.249	5.561	50.7	69.7	844.74
1961	6.057	5.666	51.6	68.2	896.21
1962	6.139	5.822	54.0	66.7	1000.27
1963	6.746	6.567	53.5	68.3	1219.96
1964	7.359	7.137	52.5	68.5	1377.77

contd...

(Table 5.3 contd)

Year	Total Wages & Benefits of workers (Rs. Lakhs)	Average+ Salary & Wages for all Persons (Current)	Average+ Salary & Wages for all Persons * (Deflated)	Average+ Wages Per M.Y. worked by workers*		All India Consumers Price Index **
				Current	Deflated	
1949	153.32	1033	1053	766	781	100.0
1950	180.16	1103	1125	917	935	100.0
1951	200.44	1315	1289	1024	1004	104.0
1952	192.84	1401	1401	1011	1011	102.0
1953	195.83	1317	1279	1066	1035	105.0
1954	212.43	1278	1291	1065	1075	101.0
1955	239.94	1374	1475	1038	1114	95.0
1956	275.46	1455	1427	1089	1068	104.0
1957	317.38	1482	1376	1166	1083	109.9
1958	359.94	1550	1377	1229	1055	114.8
1959	430.87	1802	1534	1218	1037	119.8
1960	536.44	1798	1493	1237	1027	122.8
1961	589.24	1933	1580	1458	1191	124.8
1962	643.76	1985	1572	1450	1149	128.7
1963	751.46	2176	1649	1447	1097	134.6
1964	820.09	2340	1570	1555	1043	152.6

* All India Consumer Price Index Series has been used to deflated these series.

\+ Average salary or wages: Rs. per annum.

** Source: Reserve Bank of India Bulletins.

Table 5.4

Price Indicies & Capital Utilization Ratio
Used in Construction of the Capital
Series

Year	Capacity Utilization in the Paper Industry (%)	Gen. Price Index (1952-53=100) (For Calender Year)	Price Index of Plant & Machinery 1952-53=100 (For Financial Year)
1	2	3	4
1949	93.2	100.3	80.08
1950	91.8	105.2	81.42
1951	94.1	122.4	92.96
1952	93.8	101.1	100.0
1953	92.5	105.6	98.11
1954	90.0	99.7	97.10
1955	99.3	91.5	97.55
1956	91.3	102.7	99.22
1957	84.2	108.7	101.92
1958	94.2	109.7	104.05
1959	91.6	120.8	106.50
1960	86.3	127.2	112.00
1961	88.8	128.1	115.90
1962	89.4	130.3	119.70
1963	92.1	135.0	126.50
1964	88.3	145.7	130.40

Notes: (1) Capital utilization ratio (%) = $\frac{\text{Actual Output x 100}}{\text{Installed Capacity}}$, it is taken from Monthly Statistics of production of Selected Industries.

(2) Source for the Price Indicies: Office of the Economic Adviser to the Govt. of India: Index Numbers of Wholesale Prices'
Or
Reserve Bank of India Bulletins.

CHAPTER 6

Nature and Behaviour of Cost in Indian Paper Industry

6.1 Introduction:

In this chapter the objective is to estimate a longrun cost function for the paper industry of India. The cost function is a mathematical expression for the relationship between the cost of production and the quantity of output produced by a firm or industry. It is uniquely determined by the firm's or industry's production function. The empirical estimate of the cost function for an industry not only gives the cost-output relationship, but also reveals the characteristics of the technology embedded in the production function from which it is derived. In the previous chapter, we have established a linearly homogeneous Cobb-Douglas production function for the paper industry of India. We will now estimate the cost function for it and see, if the two functions (production and cost functions) give consistent results or not. Apart from this, by estimating the cost function we will be able to know the effect of input prices on cost of production in the industry. This information which is very much significant in the context of national planning

can only be provided by the cost function for the industry.

6.2 Cost Output Relationship: Some Theoretical Hypotheses:

A firm utilizes a number of inputs to produce a certain commodity. The relationship between costs and output of the commodity then essentially depends upon two things: (i) the production function describing the technical relationship between the output and the inputs, and (ii) the condition of supply of inputs. Suppose the firm produces a single homogeneous product for which the production function can be stated as:

$$y = f\,(x_1, x_2, x_3, \ldots\ldots x_n) \qquad (2.1)$$

Where y denotes the output and x_i $(i = 1,n)$ denotes the input services, all measured in physical terms per unit of time. The right hand side of this equation constitutes a major part of the total cost of production inureal terms. Assuming that the production function is a single valued one, continuous and homogeneous of degree n. By the assumption of single valued production function we mean that only one value of the output can be produced from a given set of the input services which is technological feasible. The assumption of continuiety implies that output of the commodity (y) and the input service $(x_1, x_2 \ldots x_n)$ vary together in a well defined way having the first

and second order partial derivatives. In other words, it is possible to vary some of the inputs services singly or in combination, by small amounts from any initial position, the output will then change smoothly and will not be subjected to sharp jumps. This emphasizes the possibility of continuous substitution of one input service for another without causing sharp jumps in output. With the possibility of substitution between input services, their supply becomes an important determinant of the cost of production. If the input proportions are fixed, supply of input services affects the money cost of production but not the real cost of production which we have interpreted earlier as consumption of input services to produce the commodity. In this case, the production function remains as the sole determinant of the real cost of production.

The most important characteristic of the production function that determines the shape of average and marginal cost curves for the commodity is the 'degree of returns to scale' (or degree of homogeneity) expressed by it. We have defined the 'degree of returns to scale' as the change in output of a commodity from the unit change in its inputs. In other words if all inputs are changed by 1 percent, the resultant percentage change in the output of the commodity will show the degree of returns to scale for it (Ref: Ch.5, p272). If the production function shows the increasing returns to

scale, this implies decreasing cost of production and vice versa. This is the most fundamental property of the production function which provides the basis for the theoretical hypotheses regarding the shape of average and marginal costs curves for a commodity in shortrun as well as in longrun.

As we know, in shortrun some of the factors of production cannot be varied. The invariability of the factors of production makes the average and marginal cost curves to behave in a particular way as shown below. For the sake of simplicity, we assume that the shortrun production function contains only two inputs, one fixed and another variable. Because of the fixed factor, the production function will be bounded for the variable factor, indicating the increasing returns to scale in the beginning, followed by the constant returns to scale and ultimately, the diminishing returns to scale, as the level of the variable factor increases. Further, if we assume a constant price for the variable factor, the relationship between the production function and the shortrun cost function can, then, be expressed as follows:

$$\text{A.V.C.} = \frac{p.a}{x} = \frac{p}{\text{A.P}} \tag{2.2}$$

and

$$\text{M.C} = \frac{d(p.a)}{dx} = \frac{p}{\text{M.P}} \tag{2.3}$$

where A.V.C = Average variable cost per unit of output.

M.C = Marginal cost.

A.P. = Average productivity of the variable factor.

M.P. = Marginal productivity of the variable factor.

x = Number of output units.

and p = Price of variable factor.

Thus, these basic cost components are inversely related to the average and marginal products of the variable factor. The average and marginal products rise smoothly at first (increasing returns to scale), then keep a constant level (constant returns to scale) and after that fall (diminishing returns); the cost curves behave in the opposite way and so we have the traditional U-shaped cost curves. This is the most widely accepted hypothesis for the short-run cost functions. If the restriction of the constant price for the variable factor is removed, the shape of the cost curves may not follow the set course. Further, if the assumptions of a single variable factor and a single homogeneous output are dropped and the analysis is extended to a more general case having more than one variable factors and products, the shape of the cost curves would still be similar as shown above because of the existence of some fixed factors (Hicks, 1957).

A second hypothesis about the nature of cost output variation has been provided by H.T. Davis (1941).

Denoting the output by u, total cost by Q(u) and average cost by q(u) he wrote:

"In most manufacturing enterprises, the function q(u) will tend to diminish for certain ranges of the variable u, since overhead costs remain nearly constant, while the cost of materials, labour and similar concomitants of actual production tend to increase linearly; that is to say, they increase proportionally to u.

It will be convenient to assume for the sake of mathematical illustration and without subjecting the problem at this time to statistical verification, that q(u) may be expressed approximately by a quadratic function that is, we shall write:

$$Q(u) = au^2 + bu + c$$

Hence, the average cost has then the form

$$q(u) = au + b + c/u$$ "(Davis 1941, P.125).

A third hypothesis regarding the nature of cost curves is that total cost of production varies linearly with output and thus the average and marginal costs remain constant in shortrun. This has been given first by yntema (1940) in 1940 and expounded further by Andrews in 1949 who wrote;

"In general, average direct costs per unit of product will be expected to remain constant over large

ranges of output, so long as the business continues to employ the same methods of production, and the total of such costs will vary proportionately with total output" (Andrews, 1949).

This hypothesis has been found consistent with a large body of empirical evidence (Johnston 1960), but no attempts have been made to show that this form of the shortrun cost function is a necessary consequence of some set of fundamental and self evident postulates. Supporters of this hypothesis have been content to argue either that this is what many businessmen think as their cost function (Eiteman, 1947).

So far we have discussed the hypotheses regarding the shortrun cost curves. We will now discuss their longrun counterparts. In the longrun all factors of production can be varied. The longrun production function for a firm producing a certain commodity would, therefore, be quite different from its shortrun counterpart, but what would be the shapes of the longrun total and average cost curves is difficult to say on a priori grounds. The conventional theory of the firm is not so helpful in suggesting their shapes as it is for the shortrun curves. There is, however, general agreement on two points regarding the shape of the longrun average cost curve, (1) it is an envelope of the

lowest cost points on the shortrun average cost curves (Viner, 1931) and (2) declines for the lower ranges of output for a variety of reasons given by Marshall (1938, Chapter 9), Robinson (1935, page 48), Florence (1953, pp.49-60) and others (Stigler, 1946,pp.279-283; Beacham, 1948). With given factor prices, economies of scale arise first because of the ease of dealing with large quantities. This makes the average cost to fall. Another and "probably the most generally accepted reason for falling average cost is the existence of indivisibilities in both men and capital equipment. Large machines are usually more efficient than small one. The optimum size of machine for each process may differ so that high multiples are required to reduce average costs to a minimum", (Walters, 1963).

Whatever be the reason, whether the greater degree of specialization or indivisibility, the fact is that increasing returns and correspondingly declining average costs are met when a firm expands its operations over a long period of time. Eventually, however, if the firm expands far enough, the economies of large scale production will be exhausted and a phase of constant returns and constant average costs will be met with. If the firm expands further, the stage of constant returns and constant average costs may continue or it may be replaced by the

stage of decreasing returns and increasing costs. Economists' views differ on this point. E.A.G. Robinson, for example, argued that the coordination of management and control becomes increasingly less efficient and so rising cost of management, gives rise to increasing longrun average costs (Robinson, 1935). Florence and other have criticised this rationalisation on the ground that the propositions have not been tested in any systematic empirical study. In the words of Florence: "There is little to prove the universality and inevitability of any such law of increasing costs in the longrun when manufacturers have time to get new equipment in order to meet enlarged orders or anticipated orders and have time to reorganize and delegate responsibilities" (Florence, 1953). Moreover it might also be argued that recent developments in computers and other managerial techniques have increased the relative efficiency of large management, so the argument of increasing management costs seems to be out of date. Summarising the arguments regarding the shape of longrun average cost curve, Walters wrote:

"--- the theoretical arguments suggest that the shortrun average cost curve has the typical 'U' shape although Menger has added several reservations. Theory is reasonably clear on the proposition that longrun average costs may be expected to decline at first with increasing

scale. But for high outputs the theoretical arguments do not seem to be so convincing. Choice between the alternatives must depend on the empirical evidence". (Walters, 1963, p. 41.).

The results of the main empirical studies on longrun cost functions that have been conducted so far, do not support the hypothesis of U-shaped average cost curves. A large body of the empirical evidence given by these studies is in favour of the L-shaped longrun average cost curve (Walters, 1963; Johnston, 1960; Alaga, 1969).

6.3 Empirical Investigation of the Cost-Output Relationship For Indian Paper Industry:

In pursuit of our objective, we will now estimate the cost output relationship for the paper industry of India. The model that we will use for this purpose can be derived as follows:

6.3.1 The Model:

Let the production function of the industry be expressed as:

$$y = A\, x_1^{\alpha_1}\, x_2^{\alpha_2}\, x_3^{\alpha_3} \ldots x_n^{\alpha_n} \quad u \qquad (3.1)$$

Where y is the quantity of output and x_1, x_2,... xn are inputs in physical terms; α_i (i=1,n) are coefficients

defined as the input elasticities of output; 'A' is an 'efficiency' parameter, and u is a random error term.

Let p_1, p_2, ..., p_n be the prices for the inputs x_1, x_2, ... and x_n respectively, so the total cost of production for the industry can be expressed as:

$$C = p_1x_1 + p_2x_2 + \dots + p_nx_n \qquad (3.2)$$

The production function (3.1) specifies a variety of input combination to produce a given level of output. The problem is, then, to determine that particular input combination which gives the minimum cost of production for the given level of output. For this, the rule, as given by the theory of production, is that, marginal rate of technical substitution between every pairs of inputs must be equal to the price ratio prevailing between that pair of inputs. An alternative version of this rule is, that, marginal productivity of the last unit of money spent on different inputs must be same. This equilibrium conditions for the optimal input combination (i.e. the one that gives the minimum cost of production) can be derived by minimizing the cost of production subject to the constraint of the production function for a given level of output or by maximizing the output for the given level of expenditure on inputs. Following the first approach, the equilibrium condition for optimal input combination under competitive

condition derived from Eqs. (3.2) and (3.1) can be expressed as:

$$\frac{p_1 x_1}{\alpha_1} = \frac{p_2 x_2}{\alpha_2} = \frac{p_3 x_3}{\alpha_3} = \cdots = \frac{p_n x_n}{\alpha_n} \qquad (3.3)$$

This condition of least cost or optimal input combination must be fulfilled for all levels of the output. The locus of the points where this is met for different levels of the output, is known as the expansion path. If we solve Eqs. (3.3) and (3.1) for x_i (i=1,n), we obtain n derived demand functions for inputs as:

$$x_i = \frac{k_i \, y^{\frac{1}{r}} \; p_1^{\alpha_1/r} \; p_2^{\alpha_2/r} \; p_3^{\alpha_3/r} \cdots p_n^{\alpha_n/r}}{p_i} \, v \; ; \; i = 1, n \qquad (3.4)$$

where $k_i = \alpha_i \left[A \alpha_1^{\alpha_1} \cdot \alpha_2^{\alpha_2} \cdot \alpha_3^{\alpha_3}, \cdots \alpha_n^{\alpha_n} \right]^{-\frac{1}{r}}$

$v = u^{-\frac{1}{r}}$

and $r = (\alpha_1 + \alpha_2 + \alpha_3 + \cdots + \alpha_n)$

'r' is a parameter which measures the degree of 'returns to scale'. For 'increasing returns to scale', 'r' >1; for 'constant returns to scale', 'r'$=1$; and for decreasing returns to scale, 'r'<1.

Substituting equations (3.4) in equation (3.2), we get a cost function for the industry as:

$$C = K\, y^{1/r}\, p_1^{\alpha_1/r}\; p_2^{\alpha_2/r} \cdots p_n^{\alpha_n/r}\, \upsilon \qquad (3.5$$

Where $K = k_1 + k_2 + k_3 + \ldots. + k_n$

$$= r\left[A\alpha_1^{\alpha_1}\alpha_2^{\alpha_2}\cdots\alpha_n^{\alpha_n}\right]^{-\frac{1}{r}}$$

The cost function (3.5) is a unique relationship derived from the production function (3.1). It is nothing but the reduced form of the production function. It reveals the same thing in a different way as the production function does.

If input prices are constant, eq. (3.5) can be reduced to:

$$C = K'\; y^{1/r} \qquad (3.6)$$

where $K = K\left[p_1^{\alpha_1} \cdot p_2^{\alpha_2}\; p_3^{\alpha_3} \cdots p_n^{\alpha_n}\right]^{1/r}$, is a constant.

The exponents in Eq (3.5) i.e. $\frac{1}{r}$ and $\frac{\alpha_i}{r}$ (i=1,...n) are cost elasticities with respect to output and inputs respectively. For constant returns to scale (r = 1), Eq.(3.6) reduces to a linear equation passing through the origin as:

$$C = K' y \qquad (3.7)$$

From Eqs. (3.5) to (3.7), the average cost functions can be derived on dividing both the sides of these equations by output level (y). For example, from equation (3.6) it can be derived as:

$$\frac{C}{y} = K' y^{\left(\frac{1}{r}-1\right)} \tag{3.8}$$

In this equation if $r > 1$ i.e. for increasing returns to scale, average cost (C/y) will decline with increase in y, and if $r < 1$ i.e. for decreasing returns to scale, average cost will increase with increase in y. For constant returns to scale ($r = 1$), average cost will be constant, equal to K'. Like the average cost functions, the marginal cost functions can be derived from the total cost functions (Eq. 3.5 to 3.7).

If the production function is of CES type, the associated cost function can be derived in the same way as we have done above. The derivation is somewhat cumbersome and unnecessary in context of this study, we, therefore, omit it[1]. However, the only difference between the Cobb-Douglas and CES cost functions lies in the appearance of the elasticity of substitution in the later one.

The equations 3.5 to 3.8 are linear in logarithms which can be fitted with the application of ordinary least squares procedure. In the previous chapter we have established a linearly homogeneous Cobb-Douglas production

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1. For the derivation of the cost functions from the Cobb-Douglas or CES production functions the following references may be consulted.
Ferguson (1969), Brems (1968) and Nerlove (1965).

function for the paper industry of India. Its cost function, therefore, must be linear in the form as shown by Eq. (3.7) if price variables are kept constant. For changing price variables, Eq. (3.5) must give the unitary cost elasticity with respect to y ($\frac{1}{\gamma} = 1$). From the empirical results shown below we will be able to test the validity of these propositions.

6.3.2 The Data:

The cost data have been taken from the CMI and ASI reports. The items included in the total cost of production are as follows:

(a) Capital Cost: Which includes the amount of depreciation and imputed interest on the total capital (fixed and working) employed in the production. A constant interest rate of 7% has been assumed to compute the amount of the imputed interest.

(b) Labour Cost: This includes wages, salaries and other payments made to all persons employed in the industry.

(c) Fuel and Power Costs:

(d) Material Costs at the Factory:

(e) Other Miscellaneous Costs such as inward transportation costs if they are not included in the cost of materials; commission to purchasing agents; taxes and

duties on purchases; postage, stationary and printing charges; non-industrial services purchased in connection with the production and work done by other concerns for the industry.

All these cost series are shown in Table 6.1 and the explanation of the terms related to them is given in Appendix 2.1 of chapter 2. The price indicies related to four cost items have also been derived from the CMI and ASI reports. They are shown in Table 6.4. Table 6.2 contains the deflated cost series. For the capital cost, we have already assumed a fixed 7% interest rate of compute the imputed interest and depreciation rates were also more or less constant during the period 1949-64, (Ref: Table 6.4), it is, assumed to be at constant prices, i.e., we have not deflated it.

In fitting the cost functions, we have taken two types of cost and output series: Absolute series in which the cost is taken in value term (Rs. Lakhs) and the output, in quantity term (000 Tons); and Index series with 1952 as base year for both.

6.3.3 <u>Regression Fits</u>:

Variables: TC : Total cost (Rs.Lakhs).

$T\acute{C}$: Total cost, index: (1952=100

y : Output; quantity (000 Tons)

y' : output, index 1952=100

P_l : Price Index for Labour Costs

P_f : Price Index for Fuel Costs,

P_m : Price Index for Material Costs.

Price index for the capital costs has not been incorporated in the fits because of its relative constancy over the period 1949-1964 (Ref: Table 6.4).

(A) Regression fits for the cost series at currrent prices:

1. $$\ln(TC) = -0.09210 + \underset{(6.52)}{0.72392} \ln(y) + \underset{(1.64)}{0.33373} \ln(P_l) + \underset{(2.32)}{0.79919} \ln(P_f) + \underset{(2.05)}{0.43282} \ln(P_m)$$

$R = 0.99892$; $F = 1275.76$; $d = 2.075$

2. $$\ln(TC') = -5.87739 + \underset{(6.5)}{0.78720} \ln(y') + \underset{(1.27)}{0.27491} \ln(P_l) + \underset{(1.64)}{0.60960} \ln(P_f) + \underset{(2.73)}{0.61768} \ln(P_m)$$

$R = 0.99881$; $F = 1156.7$; $d = 2.47$

Both the fits are highly significant as shown by their F ratios which are much greater than the minimum significant limit of 5.67 at 1% level of significance with (4,11) degrees of freedom. The magnitude of the multiple correlation coefficient (R) is very high in both the fits and they are free from the autocorrelation bias since d or $(4-d) > d_u = 1.66$

(with 16 observations and 4 explanatory variables at 2% level) for both of them. Except the output (y or y'), all other explanatory variables are insignificant at 1% level of significance but at 5% level the material price index (p_m) is also, a significant cost factor. The fuel price index (P_f) gets significant coefficient at 5% level in Eq. (1) but in Eq.(2) it is significant at 10% level. Thus, in comparison with the material price index (P_m), the fuel and labour price indices (P_f and P_l) are virtually insignificant cost factors in the paper industry of India. There are two possible explanations for this: (1) The shares of labour and fuel costs in the total cost of production of the industry during the period under study varied between 14 to 20% and 9 to 12% respectively. (Ref: Table 6.5). Taking them separately, these are very small parts of the total cost. Therefore, the effects of the price variation for them might have been too low in bringing appreciable changes in the total cost of production of the industry. (2) The three price indices, P_l, P_f and P_m, used in the above cost functions are not truely independent of each other. The partial correlation coefficients for different pairs of these indices were found very high in magnitude varying between 0.920 and 0.965. This correlation among these price index series seems to be because of their

common trend, otherwise, it is unlikely that prices of labour, fuel and materials should vary together. Whether it is true or spurious, such a high degree of correlation among the explanatory variables might have given the multicollinearity bias to the estimates of the parameters of P_l and P_f making them insignificant.

For the insignificance of labour price (P_l), we have one more explanation. We know, in production labour can be substituted by capital which reduces its effect on cost of production. In the paper industry of India, the capital - Labour ratio was rising during the period under review. This implies substitution of labour by capital and hence decline in the role of labour prices (P_l) as a significant cost factor.

In view of the above possibilites of P_f and P_l being insignificant cost factors, we have dropped them from the list of explanatory variables for the cost function of the industry in the next round of estimation. The material price index (P_m) has been retained, because, the material cost alone constituted around 50 to 60% share in the total cost of production of the industry during the period 1949-64 (Ref: Table 6.5). With such a high percentage of the material cost, a small change in the material prices (P_m) might have considerably affected the total cost of production of the industry. The significant coefficient for the material

price index (P_m) in the above regression fits support this contention. Thus, with output (y & y') and material price index (P_m) as the explanatory variables, the revised estimates of the cost functions for the Indian paper industry are as follows:

$$3(a)\ TC = -2384.61724 + 1341.37304\ y + 19.98833\ P_m$$
$$(13.44) \qquad (1.80)$$
$$R = 0.99572; \quad F = 755.07; \quad d = 1.93;$$

$$(b)\ \ln(TC) = 3.22876 + 1.01807\ \ln(y) + 0.81897\ \ln(P_m)$$
$$(19.88) \qquad (4.51)$$
$$R = .99812; \quad F = 1724.8; \quad d = 1.47;$$

$$4(a)\ TC' = -154.98014 + 1.33990\ (y') + 1.21506\ P_m$$
$$(13.27) \qquad (1.60)$$
$$R = 0.99557; \quad F = 928.9 \quad d = 1.10;$$

$$(b)\ \ln(TC') = -4.22867 + 1.02243\ \ln(y') + 0.90722\ \ln(P_m)$$
$$(20.69) \qquad (4.79)$$
$$R = 0.99834; \quad F = 1951.2; \quad d = 1.65;$$

This time we have fitted the linear fits also for trial but they are inferior than the corresponding log fits. Log fits are significant in all respect having high values of R, F and t ratios and they are free from the autocorrelation bias ($d > d_u = 1.25$ for $k=2$, $n=16$ except in Eq. 4(a) where the test is inconclusive)

The output elasticity of the cost ($\frac{1}{r}$) is unitary in both the log fits as shown by the regression coefficients of ln(y) and ln($\acute{y}$). This gives us the first empirical evidence from this analysis in favour of the constant returns to scale (r = 1) production function for the industry, which we have established earlier in chapter 5 of this study. The material price index (P_m) has significant coefficients in both the log fits. These coefficients are the measure of the cost elasticity with respect to the material prices for the industry.

The cost functions described above are nonlinear (logarithmic) because of the effect of changes in input prices on the cost of production. If this effect is removed, the cost functions should be linear, since the industry is having constant returns to scale. Regressing the deflated cost of production on the output of the industry we have, infact, got the linear cost functions as shown below:

(B) <u>Regression Fits With Deflated Cost and Output Series</u>:

5(a) $TC = 0.34124 + 1071.86232\ y$

(S.E = 22.22)
(t = 48.18)

R = 0.99700; F = 2321.69; d =1.80;

5(b) $\ln(TC) = 0.99502 + 0.98362\ \ln(y)$;

(S.E. = 0.02138)
(t = 46.06)

$$6(a)\quad TC' = -0.71109 + 1.03490\,(y')$$
$$(S.E. = 0.023)$$
$$(t = 44.98)$$
$$R = 0.99656;\; F = 2023.71;\; d = 1.15$$

$$6(b)\quad \ln(TC') = 0.09887 + 0.98849\,\ln(y')$$
$$(S.E. = 0.0226)$$
$$(t = 43.7)$$
$$R = 0.99635;\quad F = 1906;\quad d = 1.22$$

All these fits are statistically significant. Values for t and F ratios are highly significant even at .05% level of significance. They are capable of explaining over 95.5% (R^2) variation in the total cost of production. They do not show the autocorrelation bias among their residuals ($d > d_u = 1.19$ for $K = 1$, $n=16$ at 1% level of significance). Both the linear fits (Eqs 5(a) and 6(a)) are better than the corresponding log fits but the output coefficients in both the log fits are not significantly different from 1 (unitary output elasticity of cost for constant returns to scale) at 1% level of significance. All four fits, therefore, support the hypothesis of constant returns to scale prevailing in the paper industry of India during the period 1949-1964. The cost functions almost pass through the origin (which is the condition for longrun cost function under constant returns to scale). Slight deviations from the origin as

we see in the fits, are natural because of the inexactness in the data. Moreover, for extremely low levels of output the cost output relationship may not be valid (because of the fixed cost) so the role of the nonzero constant term in Eqs 5(a) and 6(b) may be ignored.

(C) Analysis of the Residuals:

For the current and deflated total cost series, the best estimates of the cost functions are given by Equations 3(b) and 5(a) respectively. In fitting these equations we have used the absolute cost and output series. We have choosen them for the analysis that follows, because they give direct estimates of the average and marginal costs in value terms. For the sake of convenience we wrtie them again as:

$$3(b)\quad \underset{(\text{current})}{\ln(TC)} = 3.22876 + \underset{(19.88)}{1.01807}\ln(y) + \underset{(4.51)}{0.81897}\ln(P_m)$$

$$\text{or}\quad \underset{(\text{current})}{TC} = 25.254\, y^{1.01807} P_m^{0.81897}$$

$$R = 0.99812;\quad F = 1724.8;\quad d = 1.47;$$

$$5(a)\quad \underset{(\text{Constant})}{TC} = 0.34125 + \underset{(48.14)}{1071.86232}\,(y)$$

$$R = 0.99700;\quad F = 2321.69;\quad d = 1.80;$$

From Equations 3(b) and 5(a) the average cost functions for the industry can be derived as:

$$3(b') \quad \underset{(\text{current})}{ATC} = 25.254\ y^{0.01807}\ P_m^{\ 0.81897}$$

$$\text{and} \quad 5(a') \quad \underset{(\text{Constant})}{ATC} = \underset{\text{Constant}}{MC} = 1071.86232$$

The subscripts 'current' and 'constant' have been used to show the costs at current prices and at constant prices respectively. The regression residuals for the total and average costs obtained from these equations are given in Tables 6.7A and 6.7B. As shown in the tables, the residuals obtained from the total and average cost functions at current as well as at constant prices, very in size between 0 to 6.5% of the actual costs. For the costs at current prices, they are below 3% for most of the years except 1958, 1959,1961 and 1964 for which they are between 3 to 65% (Ref: Table 6.7A). In the case of deflated costs, residuals are slightly greater in magnitude than their current costs counterparts (Ref: Table 6.7B). All residuals are highly random in nature but as far as sign is concerned, they show a cyclical order. For first few years the residuals are positive indicating under estimation of the costs, but for the middle range of the series they are negative showing overestimation. After that, they are again positive except

for the year 1964.

It is a common feature of the cost functions to give higher regression residuals. This is because, cost of production is affected by so many socio-economic, political and technical factors, some of which cannot be quantified and included in the cost functions. In the words of Prof. Johnston:

"--- improved production practices may be spreading throughout the industry as time passes, the quality of the raw materials may be changing, the attitude of management to cost reduction may change with the phase of the business cycle, and so on. In general, changes which are random and unpredictable from period to period need not, and indeed cannot, be adjusted for and will show up in a greater 'unexplained' or residual variation in the statistical analysis". (Johnston, 1960, p.29).

A brief survey of what has happened in the paper industry of India during the period 1949-64, has been given in Ch. 3 of this study. In the input structure of the industry, there were some remarkable changes during this period. The industry gradually became more and more capital intensive. The number of workers declined relatively (per factory) but that of non-workers increased. The fuel consumption pattern has undergone important

changes. The consumption of coal and firewood has declined, but on the other hand, consumption of fuel oils and electricity has increased. Among basic raw materials, scarcity of bamboo forced the industry to use auxiliary raw materials such as bagasse, wastepaper and straw etc. With this, the techniques of production have undergone changes. On account of these structural changes, the cost structure of the industry was naturally bound to be changed. (Ref: Table 6.5). The cost functions shown babove might not have accounted for all these changes, and, therefore, large residuals for some years are quite possible. Moreover, the effect of the price variations for labour, fuel, and other miscellaneous activities might not have been accounted for fully in the cost functions. The inexactness in the price indicies used to deflate the cost of production might also be a source for the large residuals from the fitted cost functions expressed by equations 5(a) and 5(a').

Barring a few years, the residuals are in general very small in magnitude. The cost functions expressed by equations 3(b) and 5(a) are, therefore, reasonably acceptable fits for the paper industry of India. They have explained more than 96.5% variation in the actual cost of production of the industry for the period 1949-64.

(D) 'U'-Shaped Cost Curves:

In addition to the cost functions described above, we have fitted some more, assuming quadratic relationship between cost of production and output of the industry. In these fits the coefficients for higher order output variables (y^2 and y^3) were found statistically insignificant leading thereby to the rejection of the U-shaped cost output relationship for the paper industry of India. For example, in the following equation, we find almost insignificant coefficient for y^2 and no improvement in the value of R which we found in the simple linear fit between TC and y established earlier (Ref: Eq. 5(a)).

$$(7) \quad TC = -419.65546 + \underset{(6.33)}{1212.61377\, y} + \underset{(1.08^{*})}{39.54596\, y^2}$$

$$R = 0.997; \qquad F = 721.06$$

6.4 Estimates of the Cost Function with 'Inter-size' Cross-Sectional Data:

So far we have estimated the cost functions for the industry using the timeseires of aggregate data. These cost functions give us average estimates of the output and price elasticities of cost and degree of returns to scale for the firms operating in the industry. The constant returns to scale as shown by the fitted cost functions for

the industry does not mean that all the firms operating in the industry are having it. Some of them might be having increasing returns to scale and some decreasing returns to scale so that on the average we get constant returns to scale for all of them. A modern paper mill of moderate size (about 30,000 tonnes of capacity per year) requires heavy investment in the beginning, but investment and cost of production decline as the size of the mill increases[1]. This implies economies of scale prevailing in the industry. Empirically this can be tested by fitting cost functions for mills of different sizes, but this is not possible in this study because of the nonavailability of the inter-firm cost and output data for the industry. However, in the CMI reports such data is available for the firms grouped together in 9 different 'size' classes on the basis of the number of workers employed by them. As an experiment, using this data for the years 1955, 1956 and 1957 (Ref: Table 6.8) we have fitted some cost functions for the industry which are as follows:

Variables: TC = Total cost (Rs. Lakhs) at current Prices.

y = Total output (Rs. Lakhs) at current Prices.

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1. The following references may be consulted for this result: U.N./F.A.O. (1962,Vol.II,pp.533-35,Tables 1 to 7); and Westoby (1963, p.13).

(Since both TC & y represent cross-sectional data, the questions of their deflation, does not arise.)

Regression Fits:

1955

8(a) $TC = 1.15240 + 0.76794\ (y)$

$(SE = 0.015)$
$(t = 51.48)$

$R = 0.9987; \quad F = 2649.99$

8(b) $\ln(TC) = 0.25359 + 0.91357 \ln(y)$

$(SE = 0.019)$
$(t = 47.53)$

$R = 0.9984 \quad F = 2258.93$

1956

9(a) $TC = 1.28708 + 0.75587\ (y)$

$(SE = 0.008)$
$(t = 95.02)$

$R = 0.9996; \quad F = 9028.45;$

9(b) $\ln(TC) = 0.01932 + 0.95381 \ln(y)$

$(SE = 0.0256)$
$t = 37.12)$

$R = 0.9975 \quad F = 1378.15;$

1957

10(a) $TC = 1.08215 + 0.76385\ (y)$

$(SE = 0.0069)$
$t = 110.46)$

$R = 0.9997; \quad F = 12203.01$

10(b) $\ln(TC) = 0.22181 + 0.92477 \ln(y)$

$(SE = 0.0137)$
$(t = 67.37)$

$R = 0.9992; \quad F = 4539.47$

In this set of equations, we find, all the three linear fits having marginal superiority over their logarithmic counterparts since they have higher values for both R and F ratios. However, the difference is very much negligible. For practical purposes, both the types of fits are equally acceptable. For simplicity we may accept the linear fits which support our earlier findings of constant returns to scale prevailing in the paper industry of India. In the logarithmic fits, the output elasticity of cost i.e. the coefficient for ln(y) is significantly different from unitary. Since it is less than unitary, this implies increasing returns to scale prevailing in the industry. However, the degree of returns to scale given by the logarithmic fits is very close to unitary. This is evident from the following table:

Year	Output Elasticity of cost (Coeff. of ln(y)) $(\frac{1}{r})$	Degree of Returns to Scale (r)
1955	0.91357	1.09
1956	0.95381	1.05
1957	0.92477	1.08

As the table shows, the logarithmic fits give us almost

unitary degree of returns to scale (r) for the industry. (Statistically, however, the values of 'r' are significantly different from unity at 5% level of significance). The estimat estimates of the cost function based on 'intersize' cross-sectional data thus, support the conclusion of linear cost-output relationship that is, the constant returns to scale prevailing in the paper industry of India, which we have got earlier from the cost functions based on aggregate time series data. Alagh (1969) in his study of cost output relationship for the industry along with others, also concluded similarly. It means our estimates of the cost functions for the industry are reasonably acceptable.

6.5 Concluding Remarks:

The prime object of this chapter was to establish a long-run cost function for the Indian paper industry and thus, to have an alternative test for the constant returns to scale prevailing in the industry. The cost function has been derived from the Cobb-Douglas production function, two versions of which were fitted to data covering the period 1949-64. In one version, the total cost of production at current prices has been regressed on the quantity of output and the material price index for the industry. In another version, deflated tbtal cost of

production has been regressed on the quantity of output alone. Both the types of fits have shown unitary elasticity of cost of production with respect to the output of the industry which support the hypothesis of constant returns to scale prevailing in the industry. From the cost functions based on 'inter size' cross-sectional data, we have got further evidence in support of this hypothesis.

The effect of the changes in the prices of fuel and power sources and labour on the total cost of production of the industry was, almost, insignificant during the period under review, but the price of material was a highly significant cost factor as revealed by the cost functions for the industry.

Table 6.1

Total Cost of Production (Unadjusted for full coverage)
In Indian Paper Industry 1949-64
(At Current Prices)

Rs. Lakhs

Year	Capital Cost[1]	Labour Cost	Fuel & Power Costs	Material Costs
1949	117.14	211.28	107.93	592.14
1950	181.78	245.16	124.23	593.62
1951	203.92	283.87	142.79	794.69
1952	197.53	278.13	148.25	894.07
1953	238.27	289.61	155.60	884.49
1954	245.90	323.78	163.08	1004.30
1955	279.20	370.75	202.50	1121.22
1956	359.64	435.43	262.42	1293.51
1957	472.06	495.45	345.28	1498.93
1958	513.01	556.01	415.94	1977.89
1959	640.72	698.22	515.60	2795.50
1960	848.06	844.74	645.91	3214.64
1961	944.75	896.21	714.14	3584.62
1962	1037.33	1000.27	792.94	4074.59
1963	1324.96	1219.97	1011.98	4736.07
1964	1615.11	1377.77	1078.27	5198.70

1. Includes the imputed interest at the rate of 7% on total productive capital.

(Table 6.1 contd)

Rs. Lakhs

Year	Miscellaneous Cost[2]	Total Cost[3]	Output[4] (000 Tons)	Fixed Capital Per Factory
1949	2.36	1030.85	107.4	16.96
1950	8.97	1153.76	115.1	26.06
1951	14.07	1439.34	138.4	27.34
1952	14.01	1532.09	146.7	27.62
1953	13.19	1581.17	152.5	27.20
1954	13.98	1750.98	164.2	27.03
1955	13.98	1977.92	207.8	28.16
1956	20.65	2371.65	240.3	37.11
1957	27.55	2838.28	273.4	49.56
1958	30.35	3492.20	305.6	53.77
1959	168.93	4818.97	355.7	72.38
1960	201.00	5754.35	457.2	64.50
1961	196.13	6335.86	486.5	59.07
1962	251.50	7156.94	502.0	59.91
1963	337.25	8630.23	603.2	66.89
1964	378.74	9648.60	698.5	65.43

2. Includes Transportation costs, commission etc., paid by the industry; work done by others and other miscellaneous costs.
3. Total may not be exact because of rounding of the figs.
4. Output includes paper and paperboard, pulp for sale and other paper products manufactured by the industry.

Source: CMI:ASI Reports.

Table 6.2

Total Cost of Production in Indian Paper Industry at 1952 Prices (1949-1964 Unadjusted for Full Coverage)

Rs. Lakhs

Year	Capital Cost	Labour Cost	Fuel & Power Costs	Material Costs*
1949	117.14	273.73	119.37	672.45
1950	181.78	31.0.70	128.13	693.33
1951	203.92	302.41	147.75	892.10
1952	197.53	278.13	147.96	909.00
1953	238.27	308.10	152.24	942.00
1954	245.90	346.10	159.80	1056.12
1955	279.20	378.00	196.84	1250.54
1956	359.64	417.13	244.80	1403.11
1957	472.06	468.03	288.42	1594.06
1958	513.01	502.38	318.28	1805.03
1959	640.72	542.81	382.35	2460.26
1960	848.06	657.90	456.64	2730.99
1961	944.75	649.30	507.72	3217.10
1962	1037.33	705.98	518.04	3381.59
1963	1324.96	785.20	620.80	3884.31
1964	1615.11	824.89	643.32	4359.71

*Includes all other miscellaneous costs.

(Table 6.2 contd.)

Year	Total Cost Rs.Lakhs	Output (000 Tons)	Average Total Cost (Rs.Per Ton)	Average Material Cost (Rs. Per Ton)
1949	1182.69	107.4	1102.0	645.0
1950	1313.94	115.1	1141.0	603.0
1951	1546.18	138.4	1116.0	646.0
1952	1532.62	146.7	1044.0	620.0
1953	1640.61	152.5	1076.0	618.0
1954	1807.92	164.2	1100.0	637.0
1955	2104.58	207.8	1013.0	602.0
1956	2424.68	240.3	1009.0	583.0
1957	2822.57	273.4	1032.0	583.0
1958	3138.70	305.6	1027.0	590.0
1959	4026.14	355.7	1132.0	691.0
1960	4693.59	457.2	1024.0	600.0
1961	5318.87	486.5	1095.0	662.0
1962	5642.92	502.0	1124.0	675.0
1963	6614.27	603.2	1097.2	643.0
1964	7443.03	698.5	1066.0	624.5

Source: CMI:ASI Reports

Table 6.3

Cost of Production per Unit of Output (Rs. Per Ton) in Indian Paper Industry 1949-1964 (At Current Prices)

Year	Average Capital Cost		Average Labour Cost		Average Fuel & Power Cost	
	Rs	Index (1949=100)	Rs	Index (1949=100)	Rs.	Index (1949=100)
1949	109.1	100.0	196.7	100.0	100.5	100.0
1950	158.0	144.8	213.1	108.3	108.0	107.4
1951	147.3	135.1	205.1	104.2	103.2	102.6
1952	134.6	123.4	189.6	96.4	101.0	100.5
1953	156.3	143.3	190.0	96.6	102.1	101.6
1954	149.7	137.3	197.1	100.2	99.3	98.8
1955	134.7	127.2	178.4	90.7	97.5	97.0
1956	149.7	137.2	181.2	92.1	109.2	108.7
1957	172.7	158.3	181.2	92.1	126.3	125.7
1958	167.9	153.9	181.9	92.5	136.1	135.4
1959	180.1	165.1	196.3	99.8	145.0	144.2
1960	185.5	170.1	184.8	93.9	141.3	140.6
1961	194.2	178.0	184.2	93.6	146.8	146.1
1962	206.7	189.5	199.3	101.3	158.0	157.2
1963	219.7	201.4	202.3	102.8	167.8	166.9
1964	231.2	212.0	197.2	100.3	154.4	153.6

contd....

(Table 6.3 contd.)

Year	Average Material Cost		Average Total Cost	
	Rs	Index (1949=100)	Rs.	Index (1949=100)
1949	553.6	100.0	959.9	100.0
1950	523.6	94.0	1002.7	104.5
1951	584.3	105.5	1039.9	108.3
1952	618.9	111.8	1044.2	108.8
1953	588.8	106.4	1037.1	108.0
1954	620.0	112.0	1066.1	111.1
1955	541.7	97.8	951.9	99.2
1956	546.9	98.8	987.0	102.8
1957	557.9	100.8	1038.1	108.1
1958	657.1	118.7	1143.0	119.1
1959	833.4	150.5	1354.7	141.1
1960	747.1	135.0	1258.6	131.1
1961	777.2	140.4	1302.4	135.7
1962	861.9	155.7	1425.8	148.5
1963	841.1	151.9	1430.8	149.1
1964	798.5	144.2	1381.3	143.9

Source: CMI:ASI Reports

Table 6.4

Price, Costs and Output Indicies (1952=100) for Cost Functions

Year	Price of Capital (Deprecia-tion only)	Price of Labour Per Person employed	Price of Fuel and Power	Price of Materials	General Price Index
1949	99.26	73.50	90.23	87.53	100.30
1950	98.42	78.72	96.75	85.12	105.20
1951	100.74	93.85	96.44	87.51	122.40
1952	100.00	100.0	100.00	100.00	101.10
1953	101.53	94.01	101.87	94.49	105.50
1954	101.62	91.21	101.85	95.36	99.70
1955	102.72	98.08	102.67	89.27	91.50
1956	105.47	103.89	106.97	91.27	102.70
1957	104.60	105.86	119.46	93.65	108.70
1958	105.28	110.68	130.40	110.56	109.70
1959	106.60	128.63	134.53	115.93	120.80
1960	107.22	128.40	141.16	119.37	127.20
1961	109.51	138.02	141.04	115.30	128.10
1962	106.50	141.69	152.76	132.08	130.30
1963	106.80	155.37	162.59	125.95	135.00
1964	104.51	167.03	167.26	128.47	145.70

contd...

(Table 6.4 contd.)

Year	Output Index	Total Cost at Current Prices	Total Cost at 1952 Prices	Material Cost at Current Prices	Material Cost at 1952 Prices
1949	73.19	67.22	77.8	66.50	74.00
1950	78.42	74.37	85.6	67.00	76.20
1951	94.33	93.45	100.9	88.8	98.10
1952	100.00	100.00	100.0	100.0	100.00
1953	103.90	103.97	107.0	98.9	103.60
1954	111.93	114.06	118.0	112.1	116.10
1955	141.61	128.82	137.4	125.5	137.60
1956	163.76	154.12	158.2	144.7	154.70
1957	186.34	185.06	180.9	167.5	175.20
1958	208.28	229.96	204.8	221.3	196.80
1959	242.42	317.27	262.7	312.7	270.60
1960	311.59	378.11	312.8	351.0	300.40
1961	319.29	417.68	347.7	400.1	354.00
1962	342.09	471.15	368.3	455.8	372.00
1963	411.07	574.27	431.6	529.8	427.20
1964	476.06	645.47	480.1	581.3	479.50

Source: CMI: ASI Reports

Table 6.5

Cost Structure of Paper Industry 1949-1964

(% Shares of Different Cost Components in Total Cost of Production)

Year	Capital Cost: Imputed Interest* %	Capital Cost: Depreciation %	Salaries & Wages, etc %	Fuel Power & Lubricants %	Material Cost %	Misc. Cost. %
1949	6.75(11.36)	4.61	20.50	10.47	57.45	0.21
1950	8.95(15.77)	6.82	21.25	10.77	51.45	0.78
1951	8.30(14.16)	5.86	19.72	9.92	55.21	0.98
1952	7.66(12.90)	5.24	18.15	9.68	58.35	0.93
1953	8.73(15.07)	6.34	18.32	9.84	55.93	0.84
1954	8.10(14.05)	5.95	18.49	9.31	57.35	0.81
1955	8.26(14.11)	5.85	18.74	10.24	56.20	0.71
1956	8.64(15.6)	6.52	18.36	11.06	54.55	0.86
1957	9.11(16.63)	7.52	17.46	12.17	52.81	0.94
1958	7.67(14.68)	7.01	15.92	11.91	56.64	0.85
1959	6.83(13.29)	6.36	14.49	10.70	58.01	3.52
1960	7.37(14.74)	7.37	14.68	11.22	58.85	3.51
1961	7.36(14.93)	7.55	14.15	11.27	54.84	4.83
1962	8.53(14.50)	5.97	13.98	11.08	56.92	3.52
1963	8.15(13.35)	7.20	14.14	11.73	54.88	3.91
1964	8.70(16.74)	8.04	14.28	11.18	53.88	3.92

*At 7% Interest rate

Figs. in brackets show the % share of Total Capital Costs

Source: CMI:ASI Reports

Table 6.6

Cost Structure: All Industries 1949-1964
(% Share of Different Cost Components in Total Cost of Production)

Year	Capital Cost		Labour Cost %	Fuel Costs %	Material Costs %	Misc. Costs %
	Imputed* Interest %	Depre-ciation %				
1949	3.89(5.68)	1.79	19.34	3.36	70.87	0.75
1950	4.48(6.35)	1.87	19.95	3.68	71.09	0.91
1951	4.16(5.74)	1.58	15.78	3.25	74.32	0.91
1952	4.56(6.41)	1.85	17.92	3.92	71.19	0.52
1953	4.88(7.04)	2.16	19.66	4.31	67.97	1.02
1954	4.64(6.74)	2.10	18.40	4.11	69.56	1.19
1955	4.72(6.93)	2.21	18.08	4.01	69.58	1.40
1956	4.78(7.04)	2.26	17.38	4.02	70.12	1.44
1957	4.99(7.46)	2.47	16.80	4.33	69.87	1.52
1958	5.40(8.46)	3.06	16.99	4.29	68.25	1.51
1959	4.88(8.37)	3.49	17.59	4.85	64.71	3.42
1960	4.81(8.37)	3.56	16.57	4.94	65.29	3.83
1961	4.88(8.62)	3.74	15.72	4.99	65.58	5.09
1962	6.28(11.10)	4.82	15.95	5.36	62.08	5.51
1963	6.35(11.06)	4.71	15.63	5.82	61.25	6.24
1964	6.94(11.73)	4.79	15.58	5.43	60.90	6.36

Note: Figs. in brackets show % share of total capital costs.
* At 7% imputed interest.

Source: CMI:ASI Reports for 1949 to 1964.

Table 6.7A

Regression Residuals for Total & Average Costs at Current Prices

Year	Actual Total Cost Rs. Lakhs	Estimated Total Cost Rs.Lakhs by Eq.3b	Residuals Unexplained*	Actual Average Cost Rs.Per Ton	Estimate Average Cost Rs.Per Ton by Eq.3b	Residuals Unexplained*
1949	1031	1022	9(0.9)	960	951	9(0.9)
1950	1154	1141	13(1.1)	1003	991	12(1.2)
1951	1439	1408	31(2.10)	1040	1026	14(1.36)
1952	1532	1565	-30(-2.15)	1044	1068	-24(-2.3)
1953	1581	1556	25(1.60)	1037	1020	17(1.66)
1954	1750	1702	48(2.75)	1066	1037	29(2.76)
1955	1977	2018	-41(-2.02)	952	971	-19(-2.02)
1956	2371	2392	-21(-0.9)	987	996	-9(-0.9)
1957	2838	2921	-83(-2.9)	1038	1069	-31(-3.0)
1958	3493	3714	-221(-6.04)	1143	1215	-72(-6.3)
1959	4819	4537	282(5.8)	1354	1275	79(5.6)
1960	5754	5710	44(0.8)	1259	1250	9(0.85)
1961	6335	6063	272(4.3)	1302	1247	55(4.2)
1962	7156	7044	112(1.60)	1426	1400	26(1.0)
1963	8630	8518	112(1.3)	1431	1412	19(1.3)
1964	9649	10097	-348(-3.6)	1381	1447	-66(-4.8)

* Figs. in brackets are residuals as percentage of actual costs.

Table 6.7B

Regression Residuals for Total & Average Costs at Constant Prices

Year	Actual Cost Rs. Lakhs	Estimated Cost Rs. Lakhs by Eq.5a	Residuals Unexplained Rs. Lakhs by Eq.5a	Actual Average Cost Rs.Per Ton	Estimated Average Costs Rs.Per Ton	Difference Between Actual & Estt. Cost.
1949	1183	1151	32(2.71)	1102	1072	30
1950	1314	1234	80(6.08)	1141	1072	69***
1951	1546	1484	62(4.01)	1116	1072	44**
1952	1532	1593	-41(-2.66)	1044	1072	-28
1953	1641	1636	5(0.30)	1076	1072	4
1954	1808	1761	47(2.6)	1100	1072	28
1955	2105	2227	-122(-5.8)	1013	1072	-59**
1956	2425	2576	-151(-6.3)	1009	1072	-61**
1957	2822	2931	-109(-3.9)	1032	1072	-40**
1958	3139	3276	-137(-4.35)	1027	1072	-45**
1959	4026	3813	213(5.29)	1132	1072	-40**
1960	4694	4901	-207(-4.45)	1024	1072	-48**
1961	5319	5215	104(1.9)	1095	1072	23
1962	5643	5381	262(4.5)	1124	1072	52**
1963	6614	6465	149(2.25)	1097	1072	25
1964	7443	7488	-45(-0.6)	1066	1072	-6

* Figs. in brackets are residuals as percentage of actual costs.

** This difference between actual and average estimated cost is significant at 0.05 level of significance.

*** This difference is significant at 0.005 level of significance.

Table 6.8

Data for Cross-Sectional Cost Functions

Rs. Lakhs

Size of firms According to the No. of Person per Factory	1955		1956		1957	
	Output	Cost	Output	Cost	Output	Cost
1-20	0.90	1.24	1.85	2.06	0.12	0.19
21-49	4.65	6.42	17.64	18.90	14.31	14.19
50-99	53.89	45.97	81.34	71.85	83.42	80.50
100-249	121.32	96.07	99.95	72.15	122.17	89.73
250-499	20.03	15.51	27.01	16.60	180.30	128.97
500-999	471.05	354.57	373.20	306.60	293.94	257.11
1000-1999	737.92	518.54	926.31	653.99	800.25	566.44
2000-4999	1115.86	786.16	1331.66	1024.75	1875.98	1442.10
5000 & Above	Nil	Nil	Nil	Nil	Nil	Nil
All Firms	2334.54	1823.50	2858.97	2166.71	3370.49	2579.59

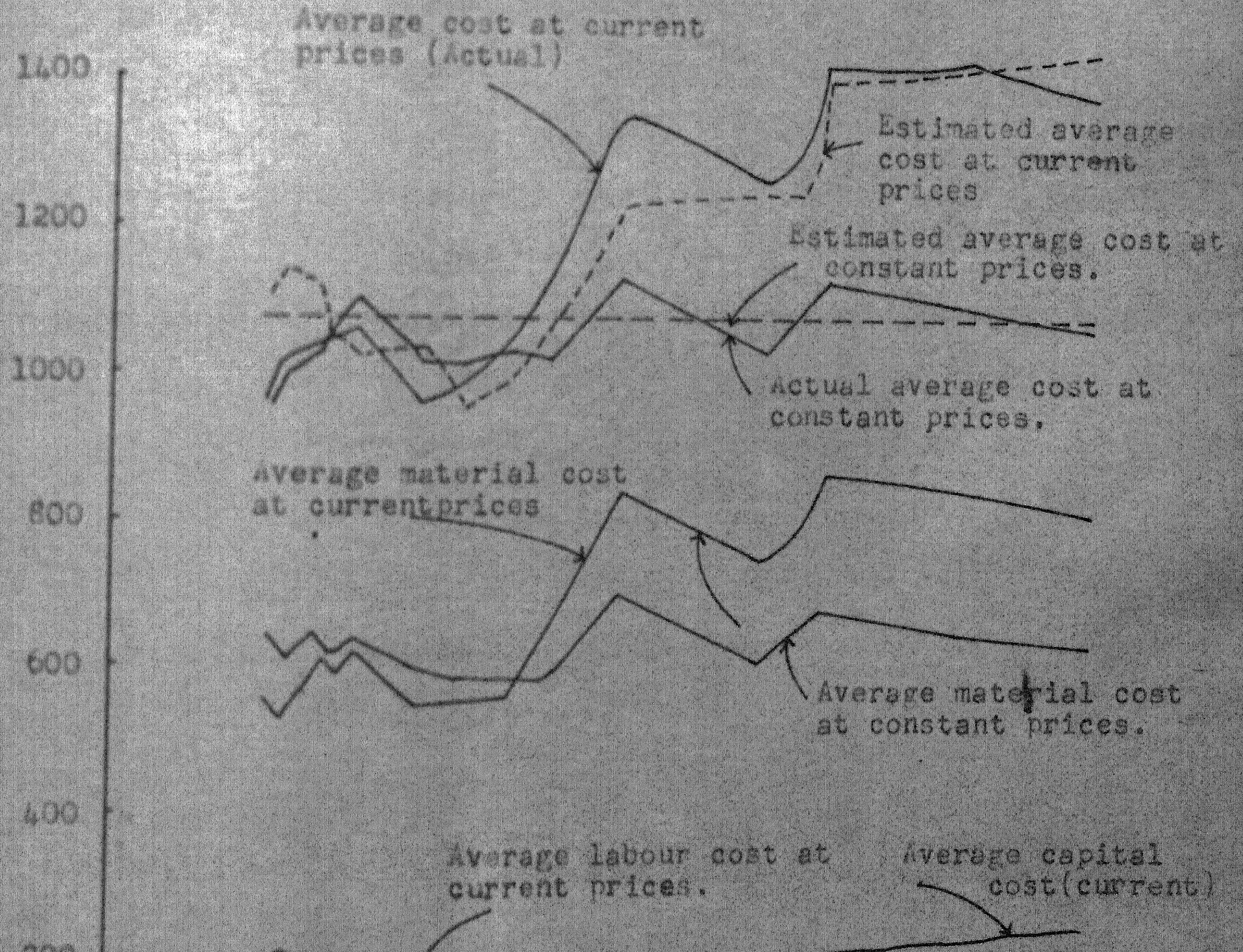

Fig. 6.1
AVERAGE COSTS -OUTPUT RELATIONS IN
INDIAN PAPER INDUSTRY

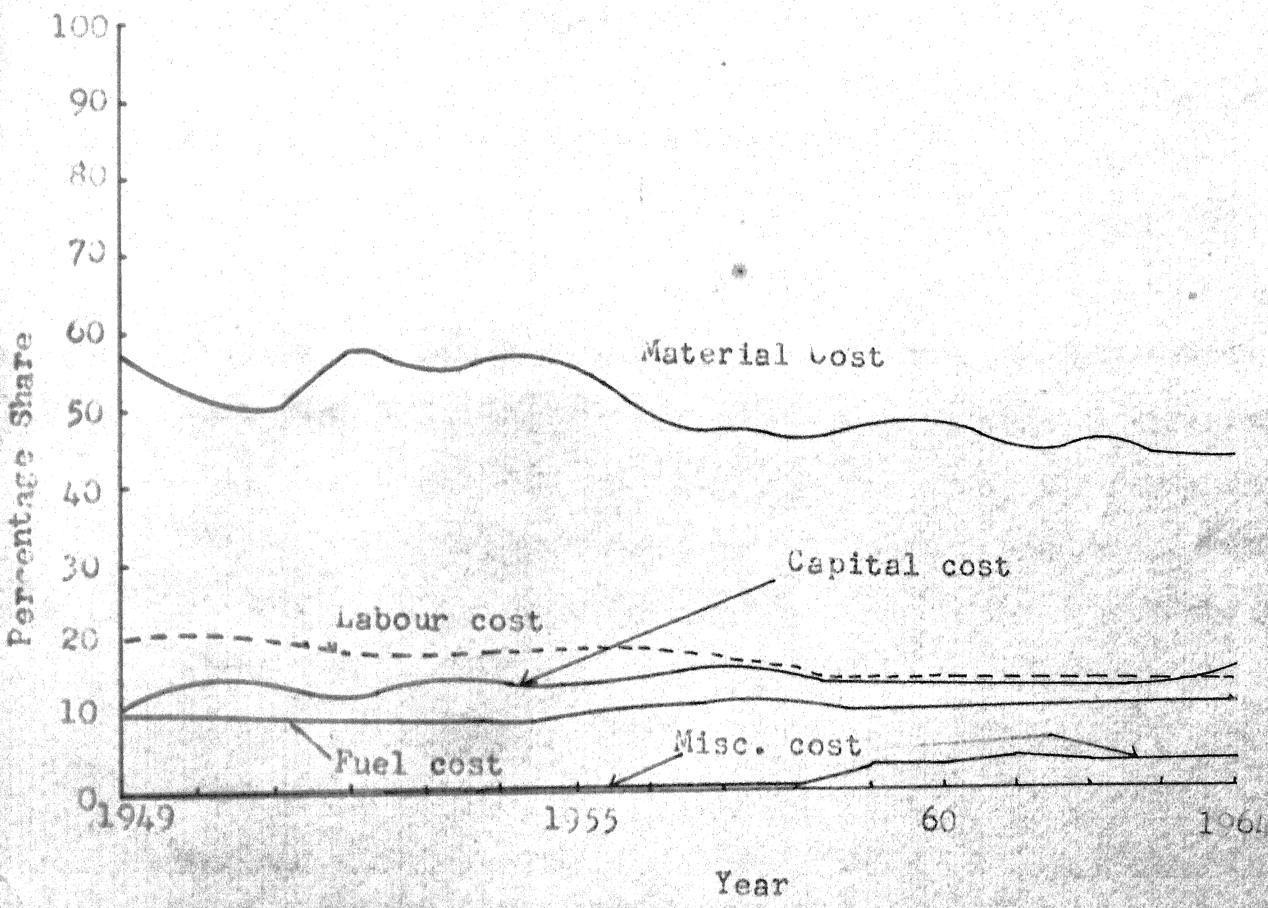

Fig. 6.4

COST STRUCTURE OF PAPER INDUSTRY 1949-64

the demand for paper and paperboard increases with the economic prosperity of a country. We got this result by correlating the percapita income and percapita consumption of paper and paperboard in 46 non-communist countries of the world. In the developed countries the industry has acquired important place among the manufacturing industries and it is still growing though with slower rates than in the developing countries. In India the industry has made very rapid progress during the past 100 years, particularly, since the beginning of the plans. The future prospects of the industry are bright in this country since the paper using sectors such as education, mass communication, business and industries, etc., are expanding day by day.

In chapter 2, we have given a brief description of the sources of data and estimation procedures for the variable used in this study and in chapter 3, the historical trends in various categories of inputs and outputs have been analyzed covering the period 1948-64. During this period the annual rate of growth of the fixed capital in the industry was more than double of the rate of growth in the labour input resulting in a rising trend in the capital-labour ratio. The rise in wages, etc., was an important factor leading to more and more substitution of capital for labour. The rate of growth of the output in the industry was also slower than that of capital during the period under review. As a result of this, the productivity per unit of fixed capital (i.e. inverse

of the capital output ratio) was declining. The productivity (value of output) per person or per man-year worked was rising during the period under review in the industry, mainly, because of the rising capital intensity or what we call as 'capital deeping'.

There were some changes in the structure of different categories of inputs in the industry during the period under review. The annual growth in the total consumption of fuel and power has maintained its parity with the growth of 'plant', and machinery' part of the fixed capital. However, among the different sources of power, the relative position of coal was declining but that of fuel oil and electricity was rising. Similarly, among the basic raw materials of the industry, the relative position of bamboo was declining but that of waste paper, begasse and straw, etc., was rising.

The output structure of the industry was fairly stable during the period 1948-64. Printing and writing papers together constituted about 65% share in it and the remaining 35% share went to the industrial papers such as wrapping papers and paperboard. Profitability, judged on the basis of the percentage share of profit margin in the gross value of output, was quite impressive (11 to 20%) upto the year 1959, but soon after, because of the control on paper prices, it declined sharply to around 6 to 7.5%.

In chapter 4, the objective was to analyze the demand

for different categories of paper and paperboard in India by fitting a set of econometric models covering the period 1950-51 to 1964-65. The analysis has been made with two alternative consumption series for each category of paper and paperboard. The first series which we called by the name of 'CMI:ASI consumption Series' took into account the output of the entire industry (small scale sector as well as the large scale sector), but the second series which we called by the name of 'MBPS: Consumption Series' took into account the output of the large scale sector only. In the econometric analysis of the demand for paper and paperboard both the series gave similar results, only the quantitative results obtained from the second series were found lower in magnitudes.

The chapter has been divided into two parts. In the first part, we have made a brief description of the historical trends in the growth of the consumption of paper and paperboard in India during the period 1950-51 to 1964-65. From this description we have found an almost stable pattern of the demand for paper and paperboard in the country during the period under review. The cultural paper comprising of the printing and writing papers and newsprint, had a share of about 65% in the total consumption of paper and paperboard. The remaining 35% share was of the industrial papers comprising of the wrapping and other varieties of paper, and paperboard. The overall rate of growth in the demand for

paper and paperboard, during the period 1950-51 to 1964-54, was 8.3% per year.

In the second part of the chapter, we have dealt with the estimation of a set of demand functions for different categories of paper and paperboard. Taking into consideration the characteristics of demand for paper and paperboard such a heterogeneity in terms of use, extremely low proportion of its cost in the consumers' total expenditure, complementarily with other events and habitual nature of consumption, we have selected explanatory variables such as the national income or non-farm national income, number of students and prices of paper and paperboard, to fit the demand functions. From the preliminary estimates of the demand functions, the price variables, as expected, were found insignificant except for newsprint. The number of students was also found insignificant in most of the demand functions because of the multicollinearity arising from the high degree of correlation between it and the national income. On dropping the insignificant variables, viz., the number of students and prices, we have made fresh estimates of the demand functions taking the national income or its variants such as non-farm national income or permanent national income as the sole explanatory variable depending upon the category of paper and paperboard. For newsprint, the demand was taken as a function of the national income and import price of the newsprint. The demand for other printing

and writing papers was taken as a function of the national income only and for industrial papers i.e. wrapping and miscellaneous varieties and paperboard, it was taken as a function of the non-farm income. On estimation, the demand functions for printing and writing papers, and newsprint were found logarithmic in shape revealing constant income elasticities of the order of 2.93 and 1.44 respectively for these two categories of paper and paperboard. The linear fits of the demand function for these categories of paper and paperboard were also found equally acceptable. In fact, from practical point of view, the difference between linear and logarithmic demand functions for printing and writing papers and newsprint was, almost, negligible. The forecasting performance of the linear fits was found better. Hence, we have accepted them as the best fits of the demand functions for these categories of paper and paperboard overlooking the marginal superiority of the log fits.

The demand for the industrial papers comprising of the wrapping and miscellaneous papers and paperboard, was found to be a linear function of the non-farm national income. In other words, the marginal propensity of consumption of this category of paper and paperboard with respect to non-farm national income was fairly stable in India during the period 1950-51 to 1964-65.

Taking into account the Fourth Five Year Plan

targets of growth in the national income and nonfarm national income, we have projected the demand for different categories of paper and paperboard in the country for the year 1973-74 through our estimates of the demand functions for them. Comparing the total projected demand for paper and paperboard with the production target fixed by the Planning Commission for this year, we find a shortage of about 100 thousand tonnes in the domestic supply. This implies that by the end of the Fourth Five Year Plan period, the country may face a big shortage of paper and paperboard if it is not met through imports from abroad.

In chapter 5, empirical estimates of the production functions have been made for the Indian paper industry. The production function has been defined as an embodiment of the technology which gives the maximum output from a set of inputs that cooperate in varying proportions. It has four characteristics which describe the nature of the technology embodied in it. These are: (1) the 'efficiency'; (2) the degree of returns to scale; (3) the factor intensity and (4) the elasticity of substitution between inputs mainly the capital and labour. All these characteristics are very much useful for empirical analysis. The simplest form of the production function is known as the Cobb-Douglas production function. The CES and the VES production functions are other two important types of the production function which are widely used in the empirical analysis. These three types of the production function i.e. the

Cobb-Douglas, the CES and the VES functions constitute together a family. Their proporties are similar except that the elasticity of substitution varies in the VES production function, remains constant at any level in the CES production function and takes unitary value in the Cobb-Douglas production function. All the three production functions satisfy the basic requirements of the neo-classical theory of production i.e. the marginal products of the inputs derived from them are positive and downward sloping over the relevant ranges of inputs and they are able to characterize any degree of returns to scale.

Empirical estimates of the VES, the CES and the Cob-Douglas production functions have been made for the Indian paper industry in pursuit of our objectives of measuring the degree of returns to scale, the elasticity of substitution between capital and labour, the output elasticities of different factors of production and the technological progress in the industry during the period 1949-1964. The results overwhelmingly show constant elasticity of substitution with unitary value for the industry. They are, thus, more in agreement with the Cobb-Douglas production function. Other results that we got from the empirical estimates of the production function for the industry are, constant returns to scale and almost negligible technological progress (in Hicksian sense) in the industry during the period under review. The output elasticities of capital and labour inputs were found to

be of the order of 0.64 and 0.36 respectively.

In chapter 6, we have made empirical estimates of the cost functions which also revealed the prevalence of the constant returns to scale in the industry during the period 1950-51 to 1964-65. Through the estimates of the cost functions, we were able to measure the effect of the changes in the input prices on total cost of production in the industry. The total cost of production was virtually inelastic with respect to prices of capital services, labour and fuel inputs. Only for the price of material input, the cost elasticity was found significantly high varying in magnitude between 0.60 to 0.65, but from the fits in which the material price index was taken as a representative of the prices of all other inputs, the cost elasticity was found to be of the order of 0.80 to 0.90.

The study suffered from some limitations. The major one was regarding the availability of good quality data. Particularly, the price indices used to deflate the variables were very much crude. Some important data series were not available at all. The time series of literacy was one of them. We have estimated the aggregate production and cost functions for the industry. Such fits give us average results about the relevant parameters such as degree of returns to scale and elasticity of substitution, etc., for all the firms operating in the industry. If the production and cost functions are

fitted for the individual firms, the result may be different. We could not do so in this study because of the non-availability of firm wise data. From the estimates of the aggregate production function, we failed to get satisfactory measurement of the technological progress in the industry during the period under review. In fact, the capability of the aggregate production function to measure the technological progress is highly doubtful. The input-output approach is, probably, a better method to measure the technolcgical progress in an industry. We have given only a brief outline of the changes in the input-output structure of the industry in chapter 3. The detailed analysis of the technolcgical progress using the input-output framework was, however, out of the scope of this study. On the whole, inspite of the limitations, the results of this study seem to be fairly acceptable.

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